POWER

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Recognition

ONE of our readers sends us this good-by note:

I have read *Power* for twenty-five years.

Now I am out of the power field completely and do not expect to be in it again.

This is how it happened:

I worked 21 years for.....; 2 years as machinist, 15 years as engineer, 4 years as superintendent. During that time I invented, designed, built and patented machinery which saved them over a million dollars and assigned the patents to them for nothing.

My salary as superintendent was $45 a week. The plant employed about 200 men.

I asked several times for a raise and was told finally that a man would take my place on a certain day.

He did. They are paying him a thousand dollars a year more than they did me.

What is the answer?

Did he hold himself too cheap at first; reducing service to servitude from which it was impossible to recover?

Did he overestimate the value of his services? They adopted and are using his inventions.

Had he hung onto his overalls too long?

Had the plant and the ideas of the administration outgrown a superintendent that commanded only half as much as a modern bricklayer?

I do not know. I have not heard the other side.

But I do know of many cases in which old faithful servitors have been superseded with scant recognition, by new men who were better salesmen of their own, often no better, services.

F. R. Low

Is Coal Storage Worth While?

WHILE government officials, trade publications and mine operators have repeatedly urged the advisability of the purchase and storage of coal at times of low prices and flooded markets, the average user of steam coal still buys when and as needed. That this hand-to-mouth policy leads to uneconomical mining conditions, overburdening of rail facilities, to the creation of acute shortages and a runaway market, is conceded by all who have had occasion to enter the market as purchasers, especially during winter months.

Fig. 1—Above. Empty barges at tidewater

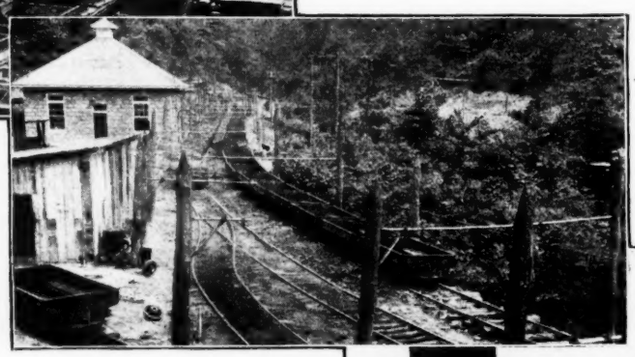


Fig. 2—Right. Idle mine equipment

Storage by consumers acts as a flywheel in evening up the fluctuations between current supply and consumption. Not only is it an insurance against temporary shortage, but it is the only protection against a protracted and general stoppage of coal delivery.

From having a few days' coal supply on hand, it has been but a step forward for the consumers to accumulate a week's or month's surplus. The more distant from the coal field the larger the surplus of coal it has become the natural thing for the consumer to pile up in storage.

After the experience of this country from 1917 to 1923 in the storage of bituminous coal, it should not be necessary to call attention to the subject. In 1918 over 60,000,000 tons of soft coal was in consumers' storage piles at the beginning of winter, an unprecedented quantity. In 1920 the lack of storage, for which the consumers were in part responsible for having used up the surplus in 1919, cost the buyers of soft coal unnecessary millions of dollars when they sought to refill their bins during the summer of that year.

Regular, systematic, large-scale storage of bituminous coal by consumers during the seasons of low consumption is the public's largest opportunity and responsbility in solving the coal problem.

The illustrations on this page typify ordinary conditions during a period of inactivity. By lack of orders the mines are compelled to store at the mine mouth what coal they can afford to hold; not only tieing up funds, but increasing the cost per ton by the handling charge. When the company's financial resources are exhausted, the mines must be shut down, the workmen are given a payless holiday, and the rolling stock allowed to remain idle. Since coal cars are of little use for anything other than coal, coke, etc., the railroad sidings are filled with empty cars, while at tidewater the barges used to carry the coal to the various seaports centers crowd every dock.

This idleness has a decided influence on the net cost of the yearly output of coal. Although, with the exception of watchmen, pumpers, etc., labor is paid only during productive hours, the miner must base his wage demand upon the number of actual working days in the year.

The direct result of this idleness is the burdening of the mines with the production of an enormous supply of coal during the autumn months, before cold weather partly shuts off the routes to the northern parts of the country. The resultant congestion is pictured in the opposite page. The mines operate double shift at maximum capacity, the quality of coal suffers since the purchaser will take practically any coal at

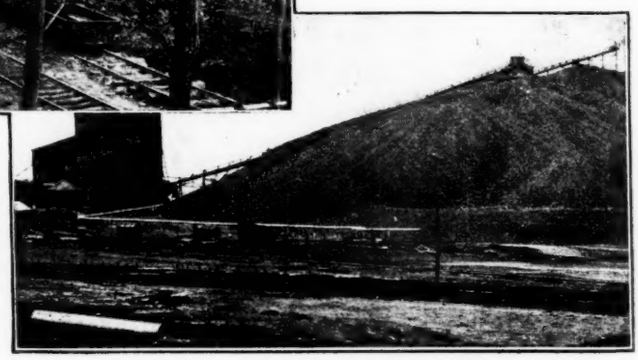


Fig. 3—Storage at mine due to lack of orders

almost any price, mine tracks are filled with loaded cars, while every siding is jammed with train after train, leading to a virtual breakdown of transportation. The cost of rail operation per ton mile during such times is high. The additional cost must be met by freight rates much above those necessary when operations were normal and peak loads eliminated by more uniform movements.

The worst effect lies in the panic occasioned by an apparent shortage. It is by no means unusual to find that the unfilled order of a single car of coal will occasion all the outward symptoms of an acute shortage. Prices rise to unjustifiable heights at such time, and the price on as much as a hundred thousand tons of coal ready for delivery has been increased as much as $1 per ton, due to the fact that orders on hand were fifty tons over the available or apparent supply. Nevertheless the coal marketer takes advantage of the situation and the public suffers even though it has full knowledge that the shortage is a fictitious one.

In the chart, Fig. 7, are shown the variations in the spot prices of Clearfield, a much-used Eastern coal and of Franklin County, Ill., coal during 1922. It will be noted that from May to September the prices on Franklin County are not shown. Owing to the mine tieup and runaway market no real market exists, prices on individual carloads varying over a wide range.

It is impossible to avoid peaks in the demand for domestic coals, for these are used mainly in the winter months. Since the financial conditions of the purchaser make it practically impossible to induce more than a minute minority of householders to put in the winter supply of coal in the spring or summer months, the mines and transportation companies must handle this stock during the autumn months, and uniformity in mining and handling can be obtained only through the users of steam coal arranging to store coal during the slack season.

A study of Fig. 7 will prove conclusively that the variations in the market prices during the year are enough to insure satisfactory returns on the investment in coal storage ground space and in a carry-over stock of coal. Although at one time spontaneous combustion was a danger, investigations have revealed the ways and means of eliminating this fire risk.

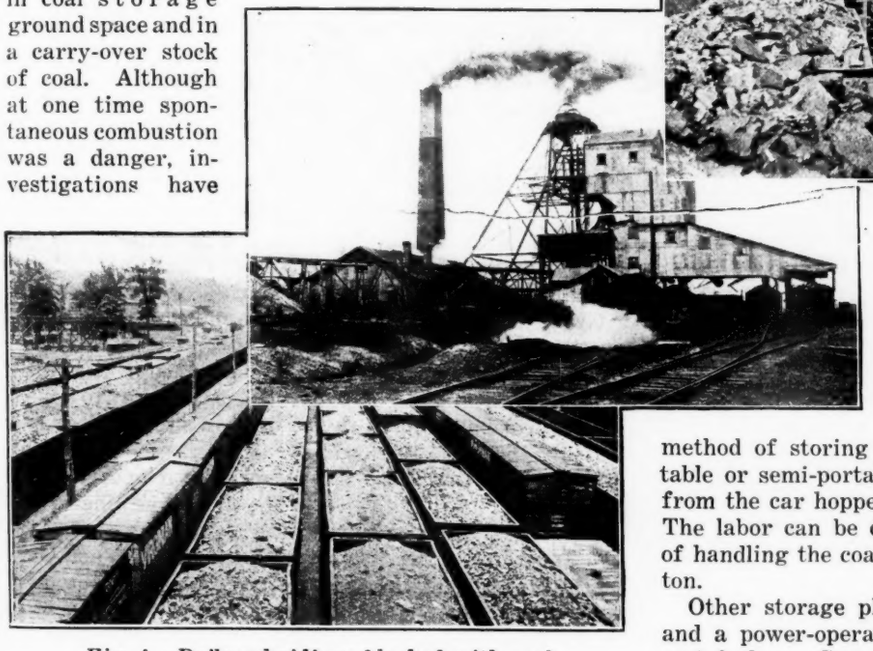


Fig. 4—Railroad sidings blocked with coal

While it is a common belief that only the larger users can afford to install the necessary equipment, it is possible to purchase equipment suitable for the storage of even a hundred tons and still show a return on the investment. Furthermore, in no case is it necessary for a supply for six months to be stored at one time.

The main object of storage is to provide a certain amount of coal on hand that may be used at any time that the coal coming in from the mines drops below consumption or the price has a tendency to rise. Even though the greater part of the steam coal used in the power plants above 1,000 kw. is bought on contract, it is a well-known fact that during a high spot market the tendency of many mine operators is to disregard their contracts and sell their output on the spot market. As a protection against such unbusinesslike ethics a stock of coal on hand will enable the power plant to be operated until such time as the mine operators decide to resume shipments or the spot market drops sufficiently to allow the power-plant owner to go into the open market and secure his supply.

The cost of storage varies widely by reason of the amount of storage and plant conditions. The most primitive form is unloading by hand into a pile convenient to the boiler room. This involves a labor expense little beyond that required when the coal is unloaded and wheeled directly into the boiler room. The expense is in the ground rent and in the interest on the coal investment only. A somewhat improved method of storing consists in using a low-priced portable or semi-portable elevator which picks up the coal from the car hopper dump and moves it to the storage. The labor can be done by one man, and the total cost of handling the coal should not be more than 10 cents a ton.

Fig. 5—Left. Coal mine in full operation

Fig. 6—Above. Mine blocked by loaded coal

Other storage plans call for the use of an elevator and a power-operated scraper. For large storage the cost is low. Conveyor belts, locomotive cranes, budge cranes, etc., are much used in this work.

Considering interest and maintenance of the mechanical equipment, interest on the coal, deterioration and shrinkage of coal, the costs range from 50 cents to 75 cents for storages of 50,000 or more, to $1.50 per ton for storages of a thousand tons. Spread over the total tonnage used in a year and figured as cost per ton for all coal used, the figure is much less, and is more than offset by the saving that is made in the purchase price of the fuel.

From all indications the bituminous-coal industry will be in an upheaval in the spring by reason of negotiations of a new wage scale. If history can be depended upon as a guide to the future, this wage controversy will be made the basis of exorbitant prices. Power-plant owners should anticipate this by studying the problems of storage of a 30- or 60-day supply of fuel before prices begin to mount.

The ability to continue operation by reason of a factory's adequate coal supply should not be ignored. Even though storage adds 50 cents to the cost of the coal the

avoidance of factory shutdown will more than justify the expenditure. Where a manufacturer is showing a gross profit of $1,000 a day and the fuel consumption amounts to 30 tons a day, or roughly 10,000 tons yearly,

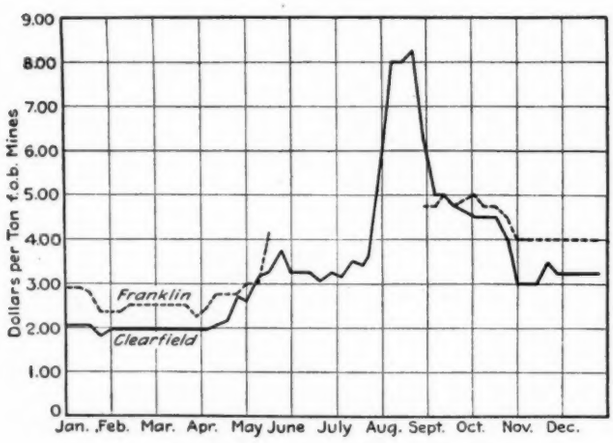


Fig. 7—Variation in 1922 coal prices

a shutdown of five days entails a loss equal to 50 cents a ton on the entire year's consumption.

[In succeeding issues of *Power* methods of storage applicable to small and large plants will be discussed.—Editor.]

New Man Runs an Ammonia Refrigerating Plant

By J. C. Lambert

One of the first things I was told when I was first introduced to an ammonia refrigerating plant was never to think of starting an ammonia compressor until the discharge valve was opened. A few incidents that happened shortly after my first introduction to this kind of machinery served to impress this on my mind.

The first experience happened to myself. I followed the chief engineer's instructions to the letter and made quite sure before I started the compressor that the discharge valve was wide open. I then followed out every other instruction in every detail and started the compressor.

The machine had turned over only a short time when the relief valves on the compressor opened up like small cannons in action. I started for the nearest door, but changed my mind and shut the throttle on the engine driving the compressor. Then I hustled out and waited for things to happen. The rest of the crew stuck to their places and gave me the laugh.

The chief showed up about this time and rather sarcastically informed me that discharge valves meant every valve between the compressor cylinder and the condenser. There was a stop valve in the discharge line at the condenser on each of the units, as well as a valve at the compressor. I had tried to start the machine with the valve in the discharge line at the condenser shut tight. After this experience I have always checked every valve up to the condenser before I attempted to start the machine.

About two weeks later we were breaking in a new man who was to work under the night chief. The new man had had considerable experience with ice machines, but was inclined to be hasty. The chief told him to start one of the two 250-ton vertical single-acting machines, which he promptly proceeded to do.

This machine had been used for pumping out another part of the system just before it had been shut down, and the man who was supposed to attend to it had neglected to close the valve to the pump-out line.

The new man started to warm up the machine by rocking the engine operating the starting bar and wrist-plate by hand. So far the discharge valves on the machine had not been opened. Suddenly there was a crash from the relief valves and the blue ammonia fumes shot toward the ceiling.

Rocking the machine produced practically the same results, so far as the ammonia compressor was concerned, as if the machine had been turning over slowly. With the valve in the pump-out line open and the pump-out line in turn connected to a condenser stand on which one of the valves was leaking, the compressor drew in a full charge of gas every time the piston moved up and in turn compressed it into the space between the discharge valve on the machine and the discharge stop valve, until the relief valves let go. After this incident I made it a point never to do anything with an ammonia compressor until I was certain that the whole discharge line was open up to the condenser.

The Oiler Pulls a Boner

Another experience that bears a close relation to the ones just mentioned happened a few weeks later. We had shut down one of the machines, and the oiler was ordered to go out on the condensers and shut off the discharge line of this machine at the condenser.

I went up on the top deck of the machine next to the one that was shut down which was still running, to make some connections to take some indicator diagrams. Without warning both relief valves began to open, while I broke all records in getting down to the floor and shutting the machine down.

The oiler came back a few minutes later and reported that he had closed the valve in the discharge line of the idle machine. The chief told him to go back again and take another look, and went out with him. When they came to check over the valves, they found that the oiler had shut off the valve on the line from the machine that was running. He had been talking to one of the repair men while he went about shutting the valve, and the valves being close together, he had grabbed hold of the wrong one.

Since this experience I have been careful about shutting valves in a refrigerating plant, particularly those on the discharge lines. If one starts to shut the valve on a machine that is working, it can readily be detected by the increasing throttling noise in the valve when it is fairly closed. It sounds much like the exhaust of steam when a valve in the exhaust line is being closed. If this sound is ever noticed, it is best to go slow and make sure that the right valve is being closed.

One day one of the men came rushing into the plant with the information that a condenser had sprung a leak. When we got out there, we found that there was no question about this part of his statement—a blue fog was shooting out of a flange near the middle of one of the stands.

One of the boys went for the ammonia mask and found it was out of order. This taught me another lesson that I have never forgotten. Always keep the protective devices around a refrigerating plant in first-

class order, because if one is out of order it is ten to one that something will happen. I have always checked the condition of the ammonia masks regularly every week since this experience.

One of the boys finally got a hose and started a stream of water playing on the leak. In a short time the fumes had disappeared enough so that we could get up to the leak, the water being played over it all the time.

Being anxious to get my hand in, I grabbed a wrench and started to tighten up on the nuts on the flange bolts. They had evidently been tightened up several times before because I was unable to budge them. Finally, one of the men gave me a hammer and told me to use it.

This helped and I managed to draw up two of the nuts quite a little bit, and the leak practically stopped. I went to work on the next nut, and I had hit the wrench about twice with the hammer when the bolt suddenly twisted off and the leak started worse than ever. Fortunately, the other three bolts held.

This cured me for all time of the desire to do any strenuous tightening on an ammonia joint under pressure. I have had occasion to tighten up loose joints under pressure a number of times since, but if they start to pull tight I leave them alone until the pressure is off unless there is something serious at stake.

The condenser coil with the leaky joint in it was then shut off at both ends and pumped out to about atmospheric pressure. The joint was opened, a new gasket of asbestos sheet packing was put in place of the old lead gasket, and the old bolts replaced with new ones. After this work was done, the joint was drawn up tight with only moderate force on the wrench.

The Engineer Is Puzzled

Finally, one Sunday came when both the chief and his assistant were off and I was delegated to run the ice machines. Everything went along fine until noon, when the brine temperatures came down so low that I decided it was time to cut out one of the machines.

I went through the routine performance of shutting down the machine, shutting off the suction and discharge stop valves at the machine, shutting off the discharge valve in the line at the condenser, and finally pumped out the discharge line to the condenser without trouble. I also pinched back on the expansion valves to compensate for the reduced capacity and I was beginning to congratulate myself for being quite an expert.

My good opinion of myself did not last very long, however. The remaining machine slowly began to lose the frost and I opened up some more on the expansion valves. This helped for a short time only, and I had to repeat the performance. I continued opening the valves until they finally were about two turns open, and conditions kept on getting worse. By this time everybody in the plant who thought he knew anything about running an ice machine was giving suggestions about what should be done, and every one who had any suggestions to offer was given a hand at it without better results. To add to our troubles the brine temperature began to go up.

The last time I went to adjust the expansion valves a soft mushy snow had formed on the liquid line back of the expansion valves, wherever it was bare. Normally, this part of the line was warm and perfectly dry. Now it was cold and covered with snow or slushy frost. I was beginning to find out that there were more troubles around a refrigerating plant than I had dreamed of.

The problem was getting too complicated for me, so I tried to call up the chief. He was not home, so I called up the assistant.

I told him as well as I could what I had done and the trouble I had got into. He promptly informed me that either I had had a blowout and lost a good part of my ammonia charge or else the ammonia had pocketed somewhere around the system. He told me to look everything over and see if I could locate the cause of the pocketing and report back in case I could not solve the trouble myself.

He Forgot the Cross-Connection

This gave me something to think about. First I went out and took a look over the condensers. Normally, every machine was run on its own condenser, but cross-connections had been provided so that the machines could be operated on all condensers in case this was desired. The machine that was running had been operated together with the one that was shut down for the last few days, and the two condensers had been tied together by opening a valve in the cross-connection.

In shutting down it had always been our practice, when any one machine was operating on its own condenser, to shut off the valve in the liquid line at the receiver of that particular condenser and then pump down until the suction pressure was somewhere around zero. With the two machines running together this of course was not possible, as the one machine was still operated on the same system. However, in shutting down the machine I had followed the regular procedure and shut off the liquid line at the receiver to keep the liquid from backing up into the condenser from the other machine, but I failed to think of the cross-connection between the discharge side of the two condensers. Furthermore, I forgot to shut the water off the condenser that was shut down. The condenser, it might be well to mention, was of the double-pipe type.

With the liquid line closed and the gas connection opened to the other condenser and with the water circulating through the condenser as usual, a large proportion of the gas passed into the idle condenser, and this gradually filled up with liquid, drawing a great proportion of the charge away from the part of the system that was in operation.

The Situation Is Cleared

To get the ammonia back into circulation I opened the valve in the liquid line of the condenser that had been shut down, while I shut off the valve in the liquid line from the condenser that had been in operation. By this method of operation the liquid was forced out of the condenser that had been shut down and to further help this along I cut off the water circulation on this condenser. As soon as I did this, I had to rush back and set the expansion valves back to normal and the machine frosted up right away.

I left the machine operating in this manner until the frost began coming off the expansion valves. Then I shut off the cross-connection between the two condensers, shut off the liquid line from the condenser that was connected to the idle machine and opened up the valve in the liquid line from the condenser of the machine that was working. This condenser by this time was loaded with liquid and the condenser pressure was coming up in a hurry. However, as soon as the valve in the liquid line was opened, the pressure dropped.

Electrical System of Combustion Control for Boiler Plants

BOILERS automatically controlled by master regulator at throttle valve, which adjusts the voltage of exciter generators connected to the field windings of the stoker, forced- and induced-draft fan motors.

IN A boiler furnace combustion is a chemical process carried on for the purpose of producing heat from fuel and air. This heat is required in varying quantities, depending on the load, therefore in so far as the demand for heat is concerned, about the only requirement of boiler regulation is to follow the demand for steam—efficiency being a matter for consideration outside of demand. Since heat in quantities sufficient to supply the momentary load is the first requirement in boiler operation and since the demand varies, the first purpose of combustion control is to follow the demand and supply the necessary fuel and air to the furnace.

The cost of producing this heat is made up of four principal items — fuel, labor, maintenance and fixed charges. Since fuel cost is by far the largest of these, it is obvious that this heat-producing process should be efficient in the use of fuel. This fixes the second object of combustion control, the efficient combination of fuel and air to obtain the most economical operation. The economical production of heat brings into consideration furnace temperature, chemical composition of the products of combustion, etc.

From the foregoing it is evident that a complete system of combustion control is essentially a station governor following the load and acting upon the elements that produce the heat necessary to carry the load, the fuel and air feeds being tied together and controlled by the demand for steam in a definite ratio to give economical combustion.

The Hess-Benjamin system of centralized combustion control as designed and built by the Benjamin Engineering Co., Cleveland, Ohio, has been developed to govern boiler plant operation electrically. In this system as applied to stoker-fired boilers, the forced-draft fans, stokers and induced-draft fans are driven with direct-current motors. The speed of these motors is controlled by an exciter motor-generator set, the voltage of which is adjusted from a master regulator which gives the initial impulse. The general arrangement of the equipment is shown in Fig. 1 and a simplified diagram of connections in Fig. 2. Instead of using an exciter generator for controlling the speed of the induced-draft fan, a damper machine may be used to adjust a rheostat in the field of the fan motor. The initial impulse to the damper machine is given by a change in pressure over the fire, the machine acting to control the speed of the fan motor to hold a predetermined pressure in the combustion chamber.

The master regulator is connected to the steam system at a point just ahead of the turbine throttle or at

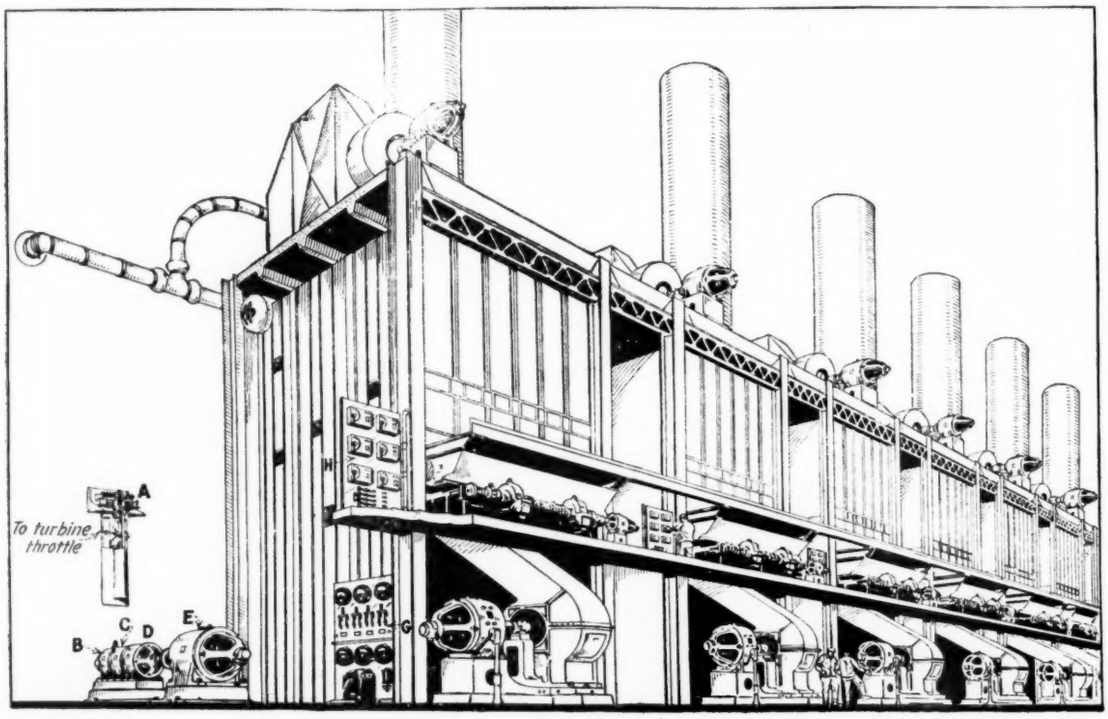


Fig. 1—All boilers are controlled automatically from a master regulator connected to the turbine throttle

A—Master regulator which controls the voltage of the exciter generators *B*, *C* and *D*, for the forced-draft fan, stoker and induced-draft fan motors. *B*—Exciter for forced-draft fan motors. *C*—Stoker-motor exciter. *D*—Induced-draft fan motor exciter. *E*—Motor for driving exciters. *G*—Control panel for exciter set. *H*—Boiler control panel.

some point on the steam-header system where the steam pressure furnishes an indication of the load on the station. In order to make the system more effective, each boiler is equipped with direct-current, adjustable-speed motors for driving the stokers and also direct-current adjustable-speed motors for driving forced-draft fans, and where induced-draft fans are used the same applied to these units. The armatures of these motors

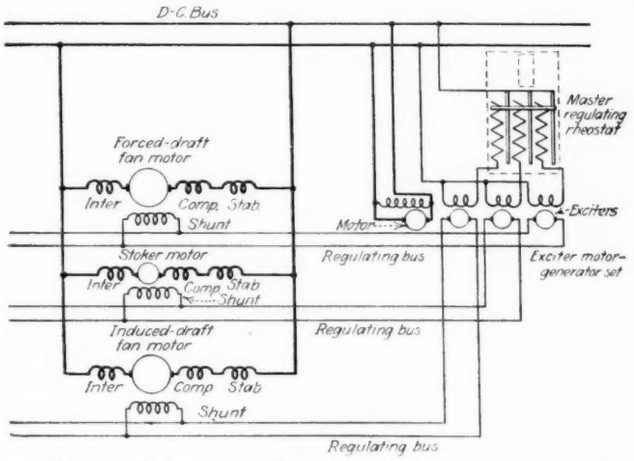


Fig. 2—Schematic diagram of combustion-control equipment for use on stoker-fired boilers

are connected to a constant-potential source of direct-current power, while the shunt fields are excited from an exciter bus energized by special generators having their shunt fields controlled by the master regulator. There is one generator and bus for all forced-draft fan motors, another generator and bus for all stoker motors, and where induced-draft equipment is used another generator and bus for the shunt fields of all induced-draft fan motors as indicated in Fig. 2. The motor-generator set for furnishing the power to the various shunt fields consists of one generator for each system of motors, all connected together on one shaft with a driving motor which is preferably a direct-current constant-speed machine.

Speed Range of Motors

The individual stoker motors are arranged to operate with a speed range of from 4 or 5 to 1, all by shunt-field control, giving a range of boiler operation of approximately 75 to 300 or 350 per cent of rating. The fan motors are arranged with a speed range sufficient to give the corresponding range of boiler operation, the same being true for the induced-draft fan motors, when used. As the exciter generators are mounted on a common shaft and have their shunt fields excited or regulated by a mechanism controlled from a single point, the relation of voltage between the various buses is fixed by a permanent adjustment made at the master regulator.

Each motor on the boiler auxiliaries is provided with a special transfer switch so that its shunt field may be energized either from the constant-potential house bus or from the exciter bus. These transfer switches are constructed so that the motors may be started on either system and transferred to the other without stopping the motors. Hand-operated field rheostats are supplied for the manual adjustment of the individual motor speeds. One rheostat is in the circuit when the shunt field is excited from the exciter bus, giving approximately 10 per cent speed adjustment, and another rheostat is in the circuit when the shunt field is energized from the house bus. These rheostats give complete speed adjustment from minimum to maximum. The rheostats, transfer switches and push buttons for controlling the automatic-starting equipment, together with meters and instruments, are mounted on individual boiler panels especially constructed of black enamel steel plate. The master panel is also supplied for the motor-generator set exciter on which are mounted push buttons, meters and rheostats for controlling the motor-generator set.

Explanation of System's Operation

In the operation of the system assume that an increased load occurs on the turbine. This will cause an increased demand for steam and a drop in the steam pressure, which will cause the master regulator, Fig. 2, to operate and move in a direction to cut resistance into the field circuits of the exciter generators, thus causing the voltage of these machines to be reduced. The reduced voltage applied to the field of the stoker and fan motors weakens their field and causes them to speed up to supply the proper amount of fuel and air to carry the new load. A reduction of load on the turbine causes a rise in pressure in the steam line, and the master regulator operates to cut resistance out of the exciter-generator's field circuits and increase their voltage, which in turn increases the excitation of the stoker and fan motors and causes them to decrease in speed to meet the new load conditions on the boilers. Thus it is seen that the master regulator causes the whole boiler plant to respond automatically to the load.

All stoker motors are so calibrated that with the same field excitation they will operate at practically the

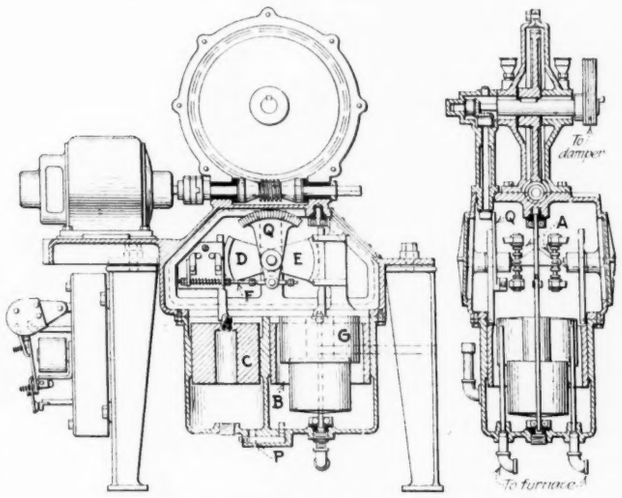


Fig. 3—Sectional views of damper machine

same speed regardless of the load imposed upon them. They are of the four-pole interpole type and are provided with special series windings controlled by an automatic starter in such a way that the motor may be started under full load with a weak field without excessive starting current or speed.

The forced-draft fan motors are of a type similar to the stoker motor, but are so compounded to suit the fan characteristics that when its speed is controlled by the exciter generator, the quantity of air delivered will be

practically constant for any given speed regardless of the varying fuel-bed resistance that may exist between different stokers on the various boilers under normal operating conditions. In the same way the induced-draft fan motors are so designed that they operate to assist the forced-draft fans in maintaining the quantity of air delivered to the furnace practically constant for a given load on the boilers.

Included with the master equipment is a special manually operated motor-field rheostat by means of which the entire station output may be increased or decreased without interfering with the automatic system. This allows, where a large change in load can be anticipated, the attendants to make adjustments quickly to meet the new condition.

Fig. 3 shows the damper machine that may be used to regulate the draft over the fire where induced-draft

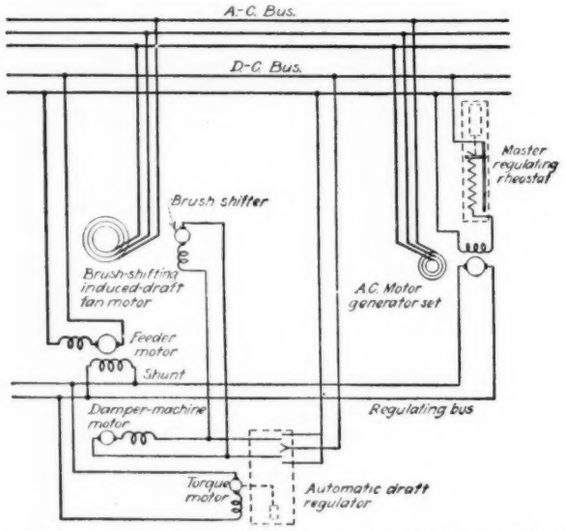


Fig. 4—Schematic diagram of combustion-control equipment for use with pulverized coal

fans are not installed. This machine consists of a gasometer *G* floating in oil and connected to the combustion chamber, a series-wound reversing motor with a worm reduction gear and the necessary limit switches and controlling reverse and dynamic-braking relays. The motor is controlled by the gasometer closing contacts to operate an automatic reversing switch to control the direction of the motor's rotation.

Referring to the right-hand section through the damper machine, Fig. 3, it will be seen that the damper is operated from a sheave on the right-hand end of the wormwheel shaft. The left-hand end of this shaft is geared through beveled gears and a vertical shaft to a quadrant *Q* that opens the contacts and stops the motor after it has been started by the gasometer and also operates the compensating devices.

Assume that the damper machine is in normal position and that an increase in load occurs on the boiler. This will cause an increased pressure in the furnace, which in turn will cause the gasometer to rise and close upper contacts *A* and start the motor in a direction to open the damper. To prevent hunting of the damper machine, two plungers extend into the oil in which the gasometer floats, one, *B*, in the gasometer chamber and the other, *C*, in a communicating chamber. These plungers are arranged to move with the driving shaft, so that when the motor starts to open the damper, it also moves quadrant *Q*, which in turn performs three other functions. It moves quadrant *D* down and *E* up and rod *F* to the right. Quadrant *D* is connected to the plunger *C* by a rack and gear, while quadrant *E* is connected in like manner to the plunger *B*, so that as the quadrants move when the damper is opening, *B* moves out of and *C* moves down into the oil. By lifting the plunger in the gasometer out of the oil, the oil level is lowered, causing the gasometer to fall away from the stationary contacts and stop the motor. By lowering the plunger in the auxiliary chamber, the oil level in this chamber is raised. These chambers are designed to have equal displacements and are connected by a communicating passage *P* through which the oil flows to equalize the level after the plungers have come to rest. The size of this bypass may be regulated to control the flow of oil to approximately the same time as is required for the effects of a new damper position to be communicated to the combustion chamber. If this new position of the damper does not give the correct draft over the fire, the gasometer will again move to correct the condition. Rod *F* is connected to the limit switches which open at the limit of damper travel and prevent the motor from overstressing the operating mechanism.

System of Control for Pulverized Coal

This system of combustion control as arranged for pulverized coal consists of a master regulator, as used with stoker-fired boilers, operating to follow the turbine or station load and controlling the voltage of a motor-generator set exciting the fields of the feeder motors. The air supply is controlled by regulating the induced-draft apparatus in such a manner as to maintain a furnace draft in such relation to the load as to obtain the proper amount of air for economical operation. This is accomplished by means of a damper machine, previously described, for operating stack dampers and by controlling the speed of the induced-draft fans. Fig. 4 shows a schematic diagram of connections for such a system using an alternating-current motor on the motor-generator set and alternating-current brush-shifting motors on the induced-draft fans. In this arrangement the pilot motors for shifting the brushes on the fan motors are controlled in parallel with the damper machine motor. In this application of the damper machine the furnace draft varies through a wide range and bears a definite relation to the load. One element is added to the damper machine, which causes the draft in the furnace to be varied by the machine in the proper ratio to the load changes. This is accomplished by means of a torque motor connected across the exciter bus for the fields of the feeder motors. This torque motor operates a plunger that varies the oil level in the gasometer of the damper machine, causing the machine to maintain a damper setting or induced-draft fan speed to maintain the furnace draft corresponding to the speed of the feeder motors. As the torque motor operates from the same bus that controls the feeder motors, the proper ratio of draft to load is automatically maintained. As the system is installed, means are provided for advancing the air control ahead of the fuel when increasing the fuel feed and the reverse when decreasing the fuel feed. This insures a sufficient percentage of excess air during transition periods to avoid smoke or incomplete combustion.

Two Kinks from Johns Hopkins

Through the courtesy of Johns Hopkins University *Power* is enabled to describe two items of equipment in use at the university mechanical laboratories that may be suggestive to engineers in general.

Fig. 1 shows a special manometer tester made at the laboratory and found to be useful in checking up draft gages and manometers such as are used for measuring air flow. The instrument consists essentially of two glass reservoirs, about six inches high, mounted on a brass base and arranged so that micrometer measurements may be taken of the water level in each reservoir. The "home-made" micrometer screws have a pitch of 20 to the inch, whole revolutions being read on the vertical steel scale and fractions of revolutions on the periphery of the micrometer wheel. This wheel has

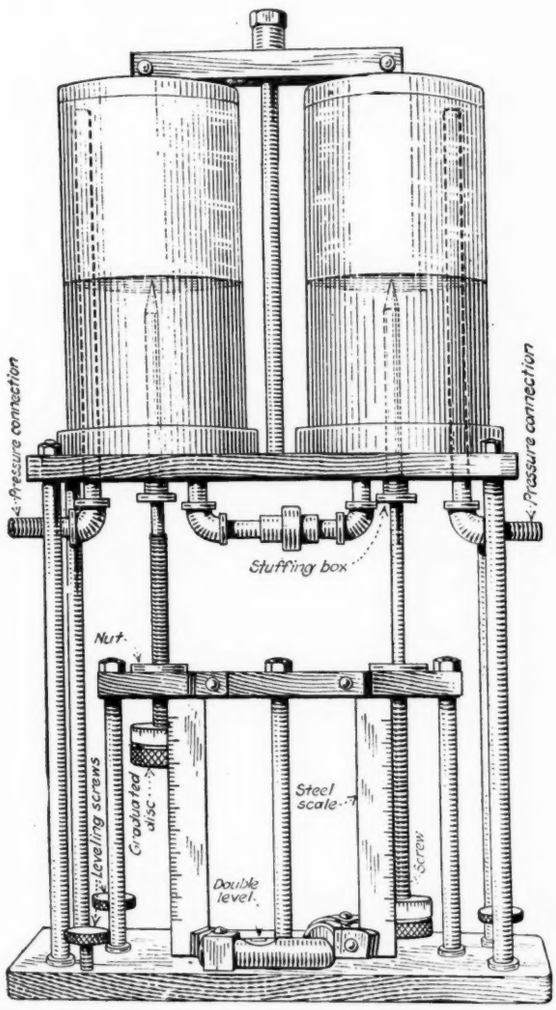


Fig. 1—Accurate device for calibrating manometers

50 graduations, each of which corresponds to one-thousandth of an inch.

To check the accuracy of a manometer, both ends of the manometer column are first exposed to atmospheric pressure to get the zero reading. The tester is set close to the manometer in a place where it will not have to be moved until the test is finished. After leveling by means of the three screw supports, zero readings are taken on both water levels in the testing apparatus by leaving the surfaces exposed to atmospheric pressure and bringing up the micrometer screws from below until the points just touch the water surface. This adjustment can be made quite accurately by noting the reflection of the sharp brass points on the under surface of the water. When the points just touch the surface, there is a sudden jump, which is easily distinguished. To repeat the reading, it is necessary to turn back the screw well below the surface and approach it again from below.

Accurate zero readings having been obtained on each water surface, the tester is connected in parallel with the manometer to be tested and any desired pressure differential applied. The difference between the new manometer reading and its zero reading is compared with the sum of the changes of the level of the water in the two reservoirs, as measured by the micrometers. This net change of level, being measureable to practically one-thousandth of an inch, gives an accurate standard with which the manometer reading may be compared.

The instrument can be used to measure either small pressures or small suctions with equal accuracy, depending on which side the manometer is connected.

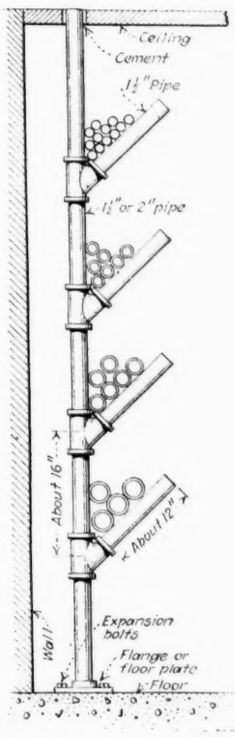


Fig. 2—Pipe Rack

Fig. 2 shows a variation of the ordinary pipe rack made of fittings. This particular rack has been used for some time at Johns Hopkins with entire satisfaction. The illustration Fig. 2 is self-explanatory.

Complete atomization is the secret of steam-cylinder lubrication. If any of the oil is carried into the cylinder in liquid state, its lubricating effect is lost, as it will either be swept out prematurely by the rush of exhaust steam or not be able to distribute itself uniformly over the wearing surfaces. The point of introduction is, therefore, of the utmost concern. In general, if this is located at a distance of from six to eight feet above or preceding the throttle valve, unless abnormal conditions arise, atomization can be depended upon to be complete by the time the lubricated steam reaches the throttle valve, and the latter will be quite as effectively lubricated and rendered capable of as efficient operation as the working parts of the engine. If the point of introduction is too close to the throttle valve or cylinder, complete atomization may not take place; if too far away, there will be a possibility of the oil particles being thrown to the walls of the steam line, from whence a flow of liquid lubricant will occur to the valve chest. In effect this might well be termed condensation of the lubricant, and it will be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest.—From an article in the November, 1923, issue of *Lubrication*.

How the Radial-Flow Turbine Compares with the Axial-Flow Type

A description of the Bonum turbine in the Dec. 18, 1923, issue, mentioned some reasons why a radial-flow type is desired commercially. It is perhaps not clear to many readers that a radial-flow reaction unit requires one-fourth as much blading, approximately, as that of an equivalent axial-flow reaction unit. This hinges on the fact that a radial-flow turbine in double rotation is equivalent to a single-rotation turbine of double the speed, as herein described.

RADIAL-FLOW steam turbines have been built and operated commercially as double-rotation units, wherein all blade rows and nozzles revolve. Each successive row moves in a direction opposite to the preceding. Axial-flow turbines, however, have not so far been adapted commercially to double rotation. Instead of all blading revolving, there are one or more stationary rows of blades or nozzles.

The principal advantage of a double-rotation unit is that, roughly speaking, it has four times the capacity of an equivalent single-rotation unit, at equal speed.

A double-rotation turbine at 1,500 r.p.m. is equal in power to the same machine at 3,000 r.p.m., single-rotation. Consider the double-rotation unit as in Fig. 1, but having the interconnecting gears between rotors removed, so that each rotor is free to change its speed without being tied to the other by gearing. Assume that with 5 hp. on each rotor, giving a total load of 10 hp., the speed in double rotation is 1,500 r.p.m. It must be remembered that each blade row goes 3,000 r.p.m. faster than the preceding row which supplies it with steam.

Now gradually stop the exterior rotor, allowing the interior to speed up, and keep the total load constant at 10 hp. When the exterior element becomes stationary and the steam conditions are unchanged, the interior rotor will deliver 10 hp. It is subject to the same torque as before, since steam conditions are unchanged, and each row of rotating blades is still operating 3,000 r.p.m. faster than the preceding row, which supplies steam. Therefore a 1,500-r.p.m. double-rotation unit is equivalent to a 3,000-r.p.m. single-rotation machine. A commercial axial-flow single-motion turbine of 3,000 r.p.m. may operate at the same capacity at 1,500 r.p.m. double rotation, if mechanical design permits.

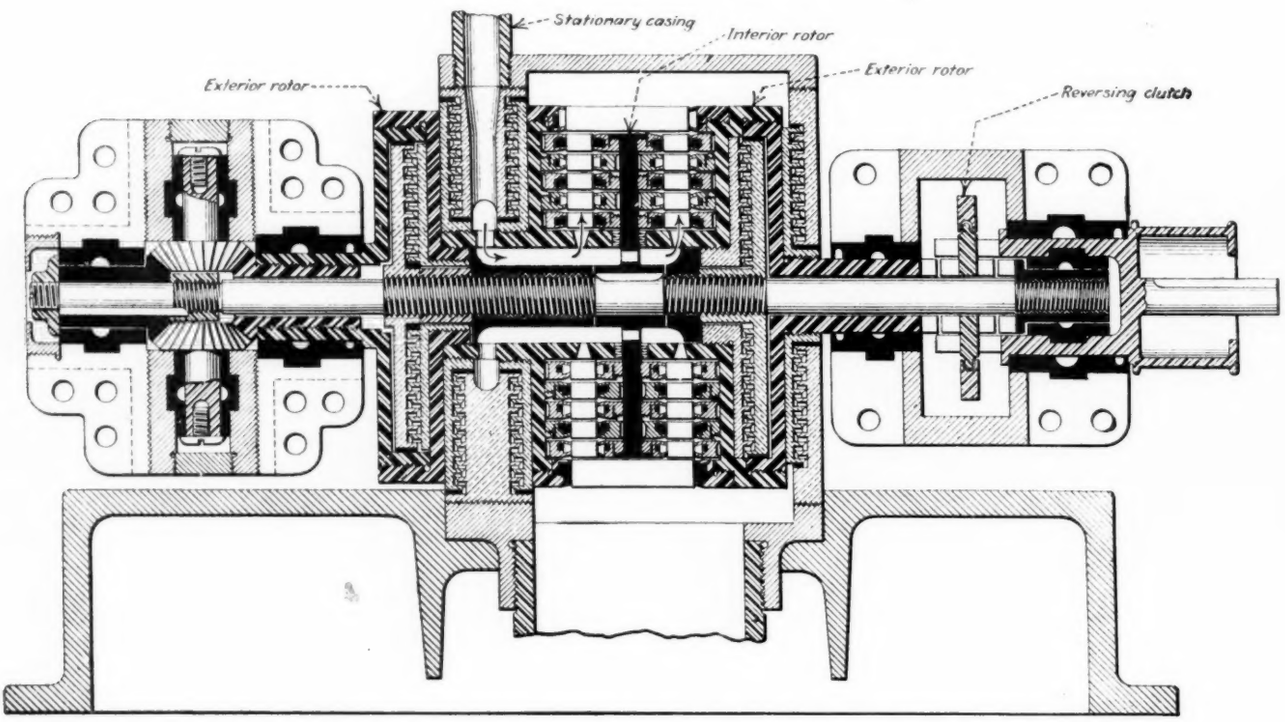


Fig. 1—Double-flow, double-rotation radial-flow turbine

Suppose we compare single- and double-rotation units of equal speeds. A double-rotation 1,500-r.p.m. turbine equals one of 3,000 r.p.m. single rotation. This has, roughly, four times the power of an equivalent 1,500-r.p.m. single-motion machine. If we cut the speed in half, the capacity is reduced approximately to one-quarter. The power varies as the square of the blade speed, other conditions being equal. The same area of blades, at one-half speed, must expand one-half the amount of steam for equal efficiency. One-half the torque at one-half the speed means one-half the power, as crudely expressed. The work done by one pound

of steam on a row of reaction blading is (from Goudie)

$$\textit{Foot-pounds per lb. steam} = \frac{\textit{blade speed} \times \textit{blade speed}}{64.4} \times \left(\frac{2\cos\alpha}{R} - 1\right)$$

where α = angle of entering steam to blade row and

$$R = \frac{\textit{blade speed}}{\textit{steam speed}}$$

Therefore, doubling blade speed and keeping other things equal quadruples the work of one pound.

These relations hold, whether the single rotation unit is either an "impulse" or "reaction" type. An impulse

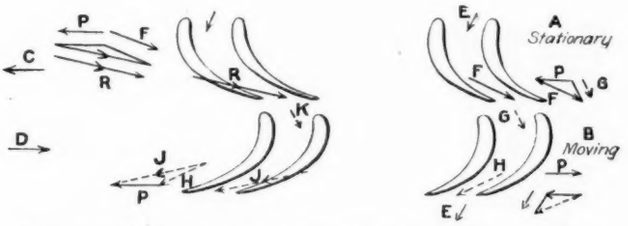


Fig. 2—Single- and double-rotation reaction blading

Row *B* moves at 1,500 r.p.m. in a single-motion turbine. Blade rows *C* and *D*, each at 1,500 r.p.m., double rotation, together have approximately four times the capacity of *A* and *B*.

type, when placed in double rotation, becomes a reaction type, since, in the latter case, nozzles also revolve. Therefore we will compare conditions in detail between reaction single and double rotation units, of equal speeds.

Two blade rows of a reaction turbine are represented at *A* and *B*, Fig. 2. The moving blade *B* travels in the direction of the arrow *P*, its length representing mean blade speed, say 400 ft. per sec. It expands steam as indicated by the dotted arrow *H*. The space between the blades represents a converging nozzle, which utilizes only a small proportion of the actual steam pressure.

Blades Should Receive Steam Moving at Blade Speed

For best efficiency the moving reaction blades should discharge steam so that it moves very little with regard to the vanes that it enters. Here it enters stationary vanes. Steam should gain sufficient velocity due to expansion and other conditions so that it will not be pulled around in the direction of rotation of the moving blades. This means in practice that the steam leaving the blades should have a speed slightly greater than the actual rate at which the blade itself is moving. The discharged steam from moving row *B* is represented by the small solid line arrow *E* to give an indication of the velocity with regard to stationary blades that it must enter. Arrows at *A* indicate expansion discharge velocity *F* as equaling both blade speed *P* and entrance velocity *G* with respect to moving blades.

In the case of the double-rotation turbine whose blading is indicated at *C* and *D*, the steam discharged from the moving vanes should have a speed equal to or somewhat greater than the next blade row which is traveling in opposite direction. It must therefore be discharged with much greater velocity, which is approximately twice that given to it in passing through the blade row *B*. Two dotted arrows *J* are therefore used to represent the velocity given to it in the blade row *D*. This steam speed is obtained by adding the speed of blade rotation *P* to the speed of expansion *H* shown at *B*, the sector addition being shown at blades *D*. (These arrows are approximate and given for purposes of explanation only.) With regard to the moving blades the steam has a slight velocity entering as shown by the small dotted arrow *K*, row *D*, whose length also corresponds to *G* entering blades *B*.

Blades in Double Rotation Expand Twice That of Single Motion

Now in order to expand the steam at *D*, Fig. 3, to twice the velocity, approximately, in the moving blades as required at *B*, about twice as much work will be done in this blade row *D* as at *B*, which can be realized from the fact that in a true reaction machine the work is done primarily by the difference in pressure of the entering and the leaving steam. In order to discharge at twice the velocity, approximately twice the pressure drop through the nozzle will be required. Therefore, to double the velocity, there will be nearly double the pressure difference tending to drive the blades in the direction of rotation. Twice the force, approximately, will therefore tend to drive blade row *D*. Consequently, about twice as much work will be done at *D* as at *B*, as expressed in a way intended to assist in visualizing the conditions.

In the case of the double-rotation turbine the moving blade *C*, which takes the place of the stationary blade *A*, must also deliver steam fast enough to enter the moving row *D*. Adding *P* to *F* gives *R* equal to *J*. The expansion will therefore be practically equal to the expansion in the blade row *D*. The moving row *C* in this case will do approximately the same amount of work as moving row *D*.

The work at *C* plus the work at *D* represents about four times the amount of that by the two rows *A* and

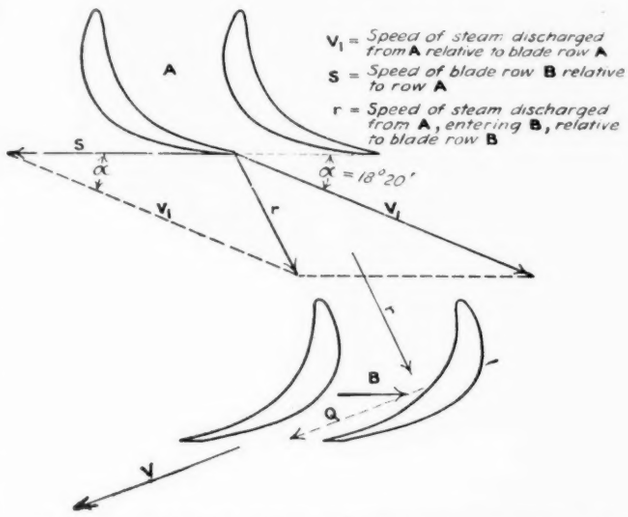


Fig. 3—Speed of steam entering moving row B *is shown at* r *as measured from row* B

B. The radial-flow machine therefore will give approximately four times as much work as that of a single rotation turbine of the same number of blade rows of equal area. It will, of course, require four times the amount of steam and special design of blading in order to produce this result with the same blade areas.

For equal capacities at equal steam pressures, the radial-flow turbine may contain one-quarter as many

blade rows. There will be available, therefore, four times as much pressure drop per row, as in the equivalent reaction unit. The blading must be designed to pass the correct amount of steam at suitable velocity with the greater pressure drop per row.

Longer High-Pressure Blades in Radial-Flow Turbine

Another factor enters to lessen the relative blading required in the radial-flow design. The innermost row of blades is of very small diameter, as compared to the outer or exhaust row. Fewer blades, of actually less material will be required than in the initial stage of an equivalent reaction unit, where a comparatively large diameter of blade row must be maintained for structural reasons. The high-pressure blade rows are relatively smaller in diameter. They are therefore longer than those of an axial-flow machine of the usual methods of construction. The longer the blades are, in proportion to the end clearances, the less is the leakage in proportion to the actual steam passing through. This is one reason why long blades in the low-pressure region in the usual turbines, with a comparatively large radial clearance in actual inches, nevertheless, have an extremely small clearance in proportion to the actual blade length. They give greater efficiency with respect to relative leakage losses than the high-pressure blades, which may be one-tenth of the length of the low-pressure vanes.

In the radial-flow double-rotation turbines shown in the Dec. 18, 1923, issue, it will be seen that the high-pressure blades actually become somewhat smaller in length as the steam expands. This is due to the fact that the diameters of the blade rows increase to a much greater degree as steam expands than is possible in the ordinary axial construction, where all blade rows are more nearly of the same mean diameter.

Higher Efficiency in Double-Rotation Units as Entering Steam Speed Is More Nearly Equal to Blade Speed

For best efficiency each moving blade row should receive steam moving approximately at its own speed or possibly a little higher. The steam supplied to each moving blade row, in a double-motion turbine, may be more closely adjusted to the actual speed of rotation than that of a single-motion reaction turbine.

In an impulse Rateau-type turbine, steam entering the blades for highest efficiency should be a little more than twice the blade speed. For blades moving 600 ft. per sec. entering steam should be $\frac{600}{0.45} = 1{,}330$ ft. per sec. approximately. The blade efficiency should be in the neighborhood of 85 per cent. For small turbines it is nearer 60 per cent. On the other hand, steam entering the blades of a reaction unit should be nearly equal to blade speed, actually somewhat greater. For 600 ft. per sec. blade velocity, the steam should enter at $\frac{600}{0.90} = 666$ ft. per sec. approximately, with a possible blade efficiency of 90 per cent. This is approached in practice only in large machines, and is not attained in small or medium-sized reaction turbines, on account of the comparatively high cost of the large number of blade rows which would be necessary. Therefore, fewer number of blade rows are utilized and a relatively higher entering steam speed, such as $\frac{600}{0.6} = 1{,}000$ ft. per sec. steam velocity. The excess speed is utilized by the impulse principle. It helps drive the moving blades in the same way that an air current drives a windmill. The usual reaction types are therefore combined impulse-reaction turbines. The maximum possible blade efficiency lies between the limits of the impulse and reaction turbine. Better efficiency is possible where reaction alone is utilized.

Each blade row of a radial-flow double-motion turbine utilizes twice the steam velocity of a similar equal speed, single-motion moving row, as before described. Fewer blade rows are therefore necessary in order to utilize the entire range of steam expansion in a double-motion machine. Therefore, commercial costs tend to allow the entering steam speed to approach more closely to the blade speed in a double-motion reaction turbine, than in one of equivalent single motion.

Among the disadvantages of radial-flow turbines is the complicated mechanical construction. With two rotating and one stationary member, labyrinth packing must be applied at a great many points. It is also more difficult to assemble a radial-flow machine on account of fitting the blade rings together than is the assembly of an axial-flow single-motion turbine. Fastening of the blade rings to the rotating elements is another matter which requires special engineering.

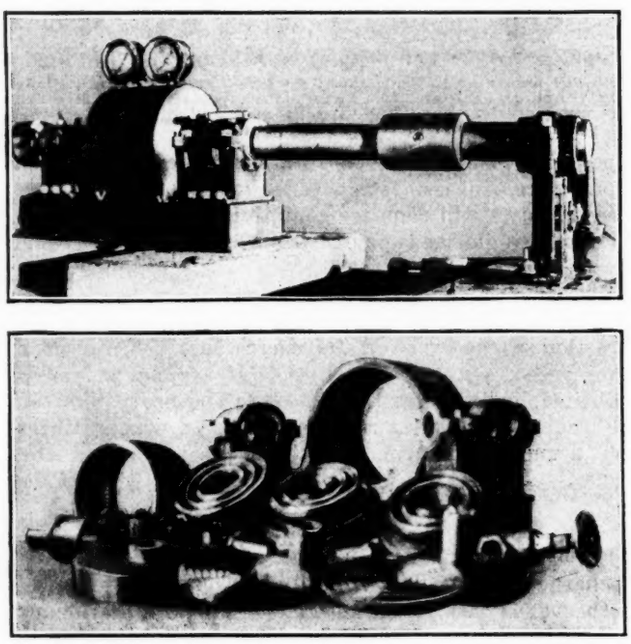


Fig. 4—A radial-flow reaction turbine with reversible drive

The radial-flow turbine of the usual design, containing one radial path of expansion, is limited in available blade area by centrifugal force and strength of materials to about 5,000 kw. The Bonom multiphase type of turbine illustrated in the Dec. 18, 1923, issue, may be built of much larger capacity. In this case the steam travels in two radial paths instead of one. Machines of more radial paths than shown, such as three-phase or four-phase or more, can be designed if conditions make it desirable.

A small double-motion turbine, with reversible drive pulley, is indicated in Fig. 4. This is designed for 5 hp. at 65 lb. gage, non-condensing. The parts, consisting

of blade rings, packing, etc., which go to make up this machine, are shown below.

Some details of a 2,000-kw. 1,500-r.p.m. two-phase Bonom radial-flow turbine were described in the Dec. 18, 1923, issue. Here the ratio of blade to steam speed was 0.7, with an expected blade efficiency of 78 per cent. By making the ratio of blade speed to steam speed constant throughout the turbine, the calculations may be greatly simplified, as shown by de Gaspe Baubien.[1] The blades in all cases have been assumed to be of a Parsons standard type, with the exception of the eleven last rows of the second stage. They are ¼-in. blades set at a one-third pitch with $\frac{1}{16}$-in. clearance. An angle of discharge will be (according to Martin) 18 deg. 20 min. with an efficiency ratio of at least 75 per cent.

Calculations from Blade Row Diameters

By using the inlet diameters of two consecutive blade rows, we may calculate the amount of work done in one reaction blade row. We will consider in a 1,500-r.p.m. double rotation turbine, that one of the rotors is stationary and the other operating at double the speed, or 3,000, for purposes of illustration, as described before in contrast to the normal speed of 1,500 with each rotor in opposite rotation, in which the same blade and steam conditions hold. In Fig. 3 the blade row at A is supposed to be stationary. Steam enters row B with a slight velocity relative to B, represented by r and expands together with this entering velocity, producing a discharge velocity V. If there are no friction or other losses in the blades, the energy in the steam at V due to the discharge velocity, will be the sum of the energy due to expansion Q (represented by the dotted arrow) and that due to r. The energy due to the velocity at V, that due to expansion Q, and that due to r may be represented (according to Martin) in the general equation,

$$\left(\frac{V}{224}\right)^2 = \left(\frac{r}{224}\right)^2 + Q$$

V and r represent feet per second, and Q B.t.u. per lb.

In practice friction losses and other causes make the actual discharge velocity V somewhat smaller than this general equation would indicate. Only about one-half of the energy r is available and approximately nine-tenths of that due to expansion Q. The equation should therefore be written with the coefficients, as observed in practice

$$\left(\frac{V}{228}\right)^2 = 0.52\left(\frac{r}{224}\right)^2 + 0.9Q,$$

$$\text{and } Q = \frac{\left(\frac{V}{224}\right)^2 - 0.52\left(\frac{r}{224}\right)^2}{0.9} \qquad (1)$$

From trigonometry we have the equation,

$$r = V_1^2 + S^2 - 2V_1 S \cos\theta \qquad (2)$$

D_B represents inlet diameter of the blade row at D Fig. 3, inches.

Since the blade speed S is equal to 0.7 times the entering steam speed V_1, we have $V_1 = \frac{S}{0.7}$. Since $\theta =$ 18 deg., 20 min., the equation (2) simplifies into $r = 7.52D_B$

Let D_C and S_C represent diameter and inlet blade speed of row C, not shown; V represents steam leaving B and entering C. Row B rotates 3,000 r.p.m. with C stationary. Row C, as measured from B, appears to move at 3,000 r.p.m. $V = \frac{ND_C}{12 \times 60} = 18.7D_C$.

Now, substituting for r and V in equation (1) we have $Q = 0.00775D^2_C - 0.000651D^2_B$.

This is the desired work per lb. steam. The pressure volume curve may then be calculated in the usual way and the area of the passages derived therefrom.

The size of the inlet passage is 35.7 sq.in., giving a steam velocity of 100 ft. per sec. There are 26 single rows of blades in the first phase. The amount of energy developed is $\frac{7.18}{30}$ of the total power of the turbine and the outlet pressure is 59.2 lb. per sq.in. absolute.

The area of the inlet passage of the second phase is 52.2 sq.in. calculated for a steam velocity of 175 ft. per sec. with 43 single rows of blades. The energy developed is $\frac{22.82}{30}$ of the total power. The blades of the last seven rows have had their angle of discharge opened slightly so as to allow keeping their length short enough to avoid undue bending moment stresses. The angle of discharge of the last row of blades is 23 deg. 8 min. The carry-over steam velocity is 555 ft. per sec.

[1]Baubien, Busfield & Company, consulting engineers, Montreal, Can.

An Oil-Engine Driven Ferryboat

By William H. Hoffman

The only direct-connected, oil-engine-driven, double-ended ferryboat in this country or abroad operates on the Hudson River between Athens and Hudson, N. Y. The over-all length of the boat is 115 ft.; the length on the load water line, 98 ft.; the moulded beam, 33 ft.; the width over the guards, 44 ft.; while the loaded draft is 7½ ft. The boat was launched at Washburn, Wis., July 4, 1921, and a few days later started east through the Great Lakes and the Barge Canal under her own power for delivery to the Hudson & Athens Ferry Co., at Hudson, N. Y.

The 2,000-mile trip of the partly completed vessel through the Lakes and canal under her own power is deserving of more detail than space will permit. Suffice it to say that the maneuvering at the many locks and hours of running through the canal at one-third speed were accomplished without a single casuality. The boat completed the run to Hudson in 14 days. This is a creditable performance when it is remembered that the machinery was new and no attempt was made to establish any records.

Upon entering the engine room, one is first impressed by the relatively small amount of machinery. On the fore and aft center line is located the main power unit, which is a six-cylinder, 11-in. bore by 15-in. stroke Price-Rathbun reversible oil engine, rated at 220 b.hp. at 300 r.p.m. The crankshaft is extended at both ends of the engine and is connected to the propeller shaftings by means of muff couplings. An unusual feature of the installation is the use of a double Kingsbury thrust bearing at one end of the engine. When the vessel is traveling in one direction, the thrust is taken directly on the thrust bearing, but when traveling in the opposite direction, the thrust must be transmitted through the full length of the engine crankshaft. This is quite different from steam-engine practice, but the Ingersoll-Rand Company, who furnished the main engine, main-

tain that an oil-engine crankshaft is so much larger in diameter than that of a steam engine and that the propeller thrust is so small compared with the other stresses acting on the shaft that no advantage would be gained by an additional thrust.

The extension of the crankshaft at the forward end made it necessary to deviate from the usual method of driving the circulating water pump and maneuvering air compresser. Consequently, the engine cooling water is supplied by a 2-in. all-bronze rotary pump and the air by a 4 and 1⅞ by 4-in. two-stage air compressor, mounted on a common sub-base and driven from the propeller shaft by sprocket wheels and silent chain.

Starting air is stored in a steel tank, 30 in. in diameter by 6 ft. long. The quantity of air for each maneuver is quite small, and at no time has the storage capacity been insufficient.

Fuel Oil Carried in Two Tanks

The fuel oil is carried in two 1,000-gal. cylindrical tanks in the wings of the engine room, one on either side of the main engine. These tanks are cross-connected, and from this connection the fuel pump, which is direct connected to the engine, takes its suction. The fuel, after being lifted by this pump to an elevated 30-gal. service tank, flows by gravity through a filter to the engine injection pumps.

The auxiliary power unit consists of a two-cylinder 15-hp. Mianus engine. The base of this engine is extended for carrying at one end a 4½x5-in. emergency air compressor and at the other a 2-in. rotary pump for general service. Belted from the flywheel is a 3½-kw.

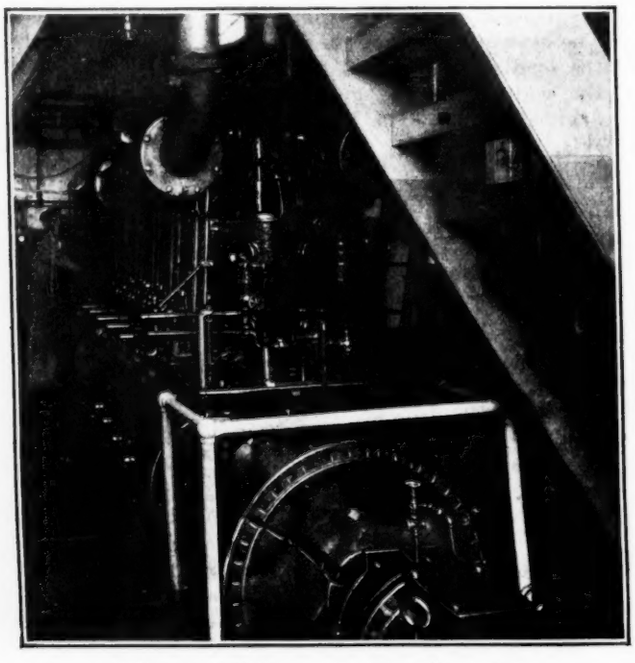


Fig. 1—220-hp. reversing oil engine

125-volt direct-current generator. The engine room is well lighted so that this auxiliary unit is not run during the day.

A small rotary pump driven from the main shafting furnishes water for sanitary purposes. In laying out the water piping, connections were made so that either the sanitary pump or the general service pump could be used for circulating cooling water through the main engine when the latter is shut down or in case the engine's circulating pump should go out of commission.

This ferry operates ten to ten and a half months a year, seven days a week, sixteen and a half hours a day. A rigid schedule calling for fifty trips a day, or one every twenty minutes is maintained. Since February 1

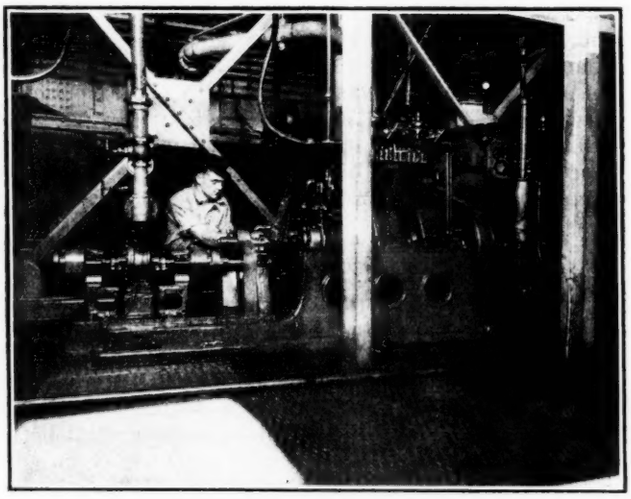


Fig. 2—Auxiliary engine supplies cooling water and light

this year only one trip has been missed, and this was not chargeable to any fault of the main engine.

No exact records of the number of maneuvers have been kept, but it is believed that eight per trip would be a fair average. This represents a total of 120,000 maneuvers for an operating season of ten months. An engine requiring a complicated reversing mechanism would not stand up under this service, and it is doubtful whether the operating engineer would be able to stand the strain very long if each maneuver called for several manual operations.

After twenty months of operation the cylinder liners and pistons were found to be in good condition. Each one shows that much-desired glazed surface, and the pistons still show the shop finishing marks. Only one piston ring, which showed a slight "blow-by," has been replaced.

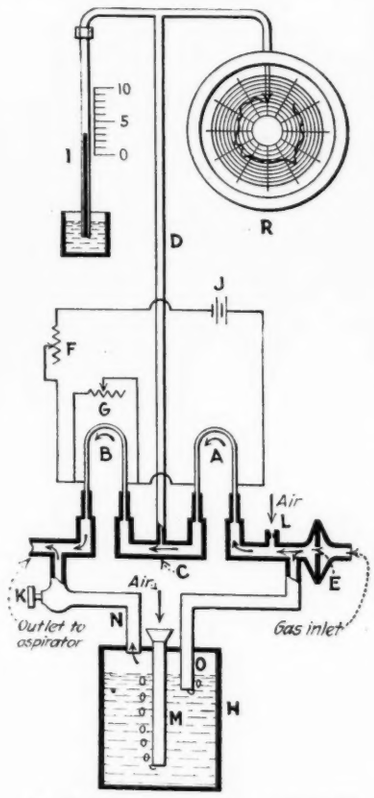
It has been found possible to maintain the oil level in the engine base within a variation of $\frac{1}{16}$ in. by the addition of one gallon of lubricating oil every other day. The engine delivers 4,000 hp.-hr. with a consumption of one gallon of lubricating oil. The season is started with clean oil in the system and it is changed twice during the season. This practice adds three more barrels to the yearly consumption, but the oil changed is not lost as it is used on the shaft bearings. The rest is disposed of to local concerns who operate rough machinery, as brick yards for instance.

In the hydro-electric field New England is setting a pace for economy in expense of operating staff. At the new 6,200-hp. station of the New England Power Co., known as the Searburg development, near Wilmington, Vermont, automatic control will eliminate the human payroll in the plant except for the visits of an oiler once a day.

New Uehling CO Recorder

To record continuously the percentage of CO in the flue gases as a means of indicating when too little air is being supplied to the furnace, the Uehling Instrument Co., of Paterson, N. J., has recently added to its line of boiler-room instruments a new CO recorder.

Referring to the illustration, a gas sample is drawn continuously through the two electrically heated platinum tubes *A* and *B*. If CO or other combustible gas is present, it burns within the heated tube *A* and increases the temperature of the tube more or less, depending on the amount of combustible present. The hotter this tube becomes the more expanded will be the gas flowing through it, and consequently less gas will enter the chamber *C*. As the outlet suction is maintained at a constant value, a decreasing flow of gas through tube *A* results in a greater partial vacuum in chamber *C*. Thus the varying suction in chamber *C* becomes a measure of the heat units in the gas, and by connecting this chamber with a recording gage *R* by means of the tube *D*, the quantity of combustible is recorded.



Construction and electrical connections of CO recorder

The recorder is calibrated in percentage of CO; however, if hydrocarbons or hydrogen is present, it will also be recorded in terms of CO of equivalent heat value. A leak is provided at *L* which dilutes the gas with air by a definite small amount so as to insure sufficient oxygen at all times to complete combustion in tube *A*. The recording gage *R* may be in the engineer's office or other convenient location. An auxiliary indicator *I* is also supplied for mounting on the boiler front to serve as fireman's guide.

Either direct or alternating current may be employed, the current consumption being about 40 watts. The diagram shows the machine operating on a storage battery *J*, with a rheostat *F* in series. The rheostat *G*, shunted with the platinum tube *B*, provides a means for raising or lowering the temperature of the tube *B* a few degrees and affords a simple way of making any slight adjustment required in the initial setting.

When the CO recorder is used independently of the CO_2 recorder, a suction regulator *H* is provided to insure a gas flow to and from the CO recorder at the proper velocity. Part of the gas entering the instrument is bypassed through the pipe *O*, bubbling up through the water in *H* and escaping through pipe *N*. The latter is connected with an aspirator or main suction through the needle valve *K*. The rate of flow depends upon the setting of *K*, which does not have to be exact so long as it is open sufficiently to cause air to bubble from the end of pipe *M* and gas to bubble from the end of pipe *O*. The suction is maintained constant all the way back to the first platinum tube *A*, regardless of any change in the tension of the gas on the inlet side of the opening *E*, caused by draft variations or otherwise.

Makeup water is added as required through the tube *M*. An arrangement similar to that used with standard Uehling CO_2 recorders, is employed for creating the primary fixed suction. A steam, air or water aspirator, as preferred, can be supplied.

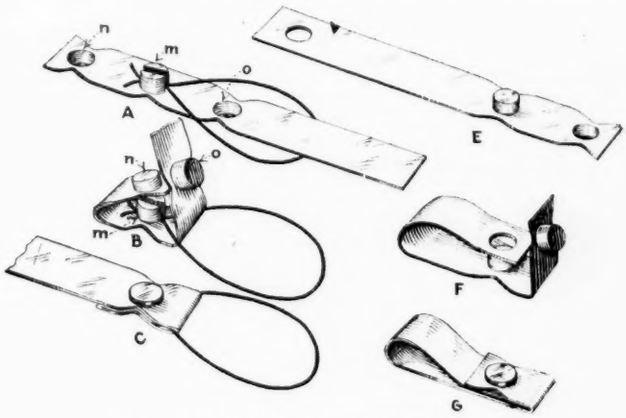
The gas line is protected by the standard Uehling "Pyro-porus" filtering, drying and desulphurizing system, and the air leak *L* is also provided with a filter. There are no moving parts, and no chemicals are employed. The instrument is speedy in action and extremely sensitive, indicating as little as ½ per cent of CO or equivalent.

Stud Locking Type of Seal

Most every engineer has at some time found it necessary or desirable to seal different instruments or accessories in his plant in order that certain adjustments cannot be altered without his knowledge. It also is oftentimes desirable to seal a valve in a certain position to prevent accidents or interruptions to service.

A seal that is especially adapted to numerous purposes in the plant, in addition to the more common use of sealing meters measuring gas and electricity on the customer's property, is shown in the illustration.

The principle of the seal is a locking stud and will be readily understood by referring to views *A*, *B* and *C*.



Details of the stud locking type of seal

The wire is placed in the slotted center stud *m*, and this is capped with the outer stud *n* holding the wire firmly in place. These two studs are capped finally by another outer stud *o*, and the whole is then crushed flat as shown in view *C* with a flat-jawed tool.

A second type of seal, shown in views *E*, *F* and *G*, is especially adapted to meters with sealing bars. The views shown are self-explanatory.

This type of seal is easily and quickly attached, gives evidence of the slightest tampering and is rustproof.

The seals are manufactured by the Decorated Metal Manufacturing Co., Brooklyn, N. Y.

Babbitt Metals and How To Babbitt Bearings

By E. Andrews

Babbitt metals for lining bearings offer a wide field for research. There are numerous brands submitted for use, for each of which special qualities are claimed. It cannot be expected that any one composition is at the same time the most suitable for use in bearings running with a light load and in others with a heavy load, with oil lubrication, and also for bearings like propeller-shaft bearings running in sea water without oil. Experience has also shown that a perfectly good babbitt metal can be made practically worthless for bearings by allowing it to become too hot or by pouring when too hot or too cold, this being more applicable to a lead-base than to a tin-base alloy.

Where the service conditions are severe owing to great pressure, a babbitt metal having considerable compressive strength is necessary, regardless of what the speed may be, and this condition would require a relatively high percentage of tin. Where there is high speed and the pressure light or moderate, a babbitt metal having a fairly high percentage of lead can be used. In the same manner, with intermediate conditions between pressure and speed, correspondingly intermediate compositions can be selected. The following alloys have given complete satisfaction for the purposes mentioned:

BABBITT METAL COMPOSITIONS

		Tin	Lead	Antimony	Copper
Used for shaftings and general heavy machinery	No. 1	80	..	10	10
	No. 2	75	..	15	10
	No. 3	70	10	10	10
Machine tools, millwork, bearings, etc.	No. 1	55	25	15	5
	No. 2	50	27	19	4
	No. 3	20	40	37	3
Light machinery		10	75	15	..
Railroad car axle bearings		15	70	15	..

In the case of babbitt, as with other metals, the rate of cooling has an enormous effect on the crystallization and structure of the metals, and this should be borne in mind by the users.

The opinion prevails among some power engineers who make their own babbitt metal, that the quality is influenced by the order in which the various metals are melted and combined. The writer made some experiments on this point on a metal of the tin-copper-antimony type by making a metal of definite composition by three separate sets of steps, all different from the orthodox method. All resulted in metals which, when fused, possessed the same chemical proportions, and when the resulting metals were cooled under identical conditions as to the rates of cooling, the microscopic structures were in each case identical with those of the metal mixed in the orthodox manner. These results indicate that with babbitt metals, shop secrets or mysteries of mixing have only a fancy value with regard to convenience or even to accuracy of the final product; they are not essential to the quality of the bearing metal. In connection with the babbitting process the following method of procedure should meet all the requirements generally specified:

Cleaning Cast-Iron or Cast-Steel Shells (untinned)—First remove all the old babbitt metal from the shell. This can be done by heating the shell sufficiently to melt out the old lining. Remove all oil, dirt or other foreign matter by dipping the shell in a strong solution of caustic potash or by burning. If the latter method is used, continue the burning until all smoke ceases, showing that all oil and dirt have been burned off completely; then scrape the surface with an old file to remove scale and oxide. Cast-iron shells are rarely tinned.

Cleaning Bronze or Steel Shells (tinned)—Remove the old lining by heating, preferably in a pot of scrap babbitt, and take care not to heat it above 698 deg. F. Immediately the old lining is melted out, swab the tinned surface with zinc chloride, then dip into a pot of molten solder (50 per cent tin and 50 per cent lead), which should be kept at a temperature not less than 626 deg. and not more than 698 deg. If the shells are to be babbitted immediately, do not handle the tinned surface after removal from the solder pot. If the shells are allowed to cool, thoroughly brush the tinned surfaces with clean waste. Zinc chloride may be had by placing strips of zinc in muriatic acid until the acid will eat no more zinc.

Tinning Bronze or Steel Shells—Cover the parts not to be tinned with a clay wash or a thin mixture of graphite and water. When dry swab the parts to be tinned with zinc chloride, then immerse the shell in a pot of molten solder, which should be kept at a temperature of about 680 deg. Leave the shell in the solder until it is hot enough for the solder to run off freely, leaving a thin coating. Remove the shell from the solder pot and rub the surface to be coated thoroughly with a swab saturated with zinc chloride, then dip in the molten solder again to eliminate all traces of zinc chloride. If any untinned places can be detected on the surface to be babbitted, repeat the operation. Babbitt metal should not be used for tinning because it has a much higher melting point than solder, which makes it somewhat difficult to maintain a molten film on the surface to be tinned.

Preheating of Mandrels and Shells—For iron or steel shells (untinned) preheat the mandrel to a temperature of approximately 300 deg. F. and the shell to around 210 deg. If the shell is heated too hot, the length of time for cooling may be so prolonged that the heavier metals in the babbitt will have time to settle to the bottom of the bearing, in which case the metal in one end of the bearing will be somewhat soft and in the other end brittle; while if the shell is too cold, it will cool the babbitt too suddenly and cause it to shrink away from the shell. After each bearing is poured, swab the mandrel with a rag dampened with clay wash. This method leaves on the mandrel surface a thin layer of fine clay dust, which assists in producing smooth, clean bearings free from blowholes and other surface defects. Avoid the use of oil, as it tends to blister the babbitt.

For Bronze or Steel Shells (tinned)—Preheat the mandrel to about 210 deg. After each bearing is poured, it may be found necessary to cool the mandrel. This is done by dipping it in a clay wash, which leaves a layer of fine clay dust. When the mandrel is at the correct temperature, the water of the clay wash will evaporate quickly on the surface of the mandrel, but will not spatter vigorously. The bronze or steel shell is preheated in the tinning process, and should be babbitted immediately after tinning, before losing the heat given to it by the tinning operation.

When melting the babbitt metal, the temperature should not be increased too rapidly. The molten metal should be stirred thoroughly at frequent intervals, and it is advisable to cover its surface with powdered charcoal or graphite to prevent oxidation. Usually, babbitt metal should be kept at a temperature about 870 deg., the exact temperature depending on the composition.

The babbitt should be poured from a ladle in a steady stream directly down the mandrel to avoid pocketing of air or splashing. Preferably, the ladle should have a rounded spout rather than one that is sharp or wide. A wide thin stream or an irregular one tends to produce blowholes or porous surfaces. The best results are invariably obtained by pouring the babbitt metal with the shell or bearing in a vertical position. Properly lined shells should ring sound when balanced on a suitable fixture and struck with a hammer; if they do not, the metal has not properly adhered to the shell and should be melted out.

The important points in babbitting a shell or bearing are briefly: Clean melting pot and ladles; clean shell or bearing; properly tinned surfaces; preheating mandrel and bearings correctly; maintaining the babbitt at a temperature of 860 to 880 deg.; pouring at the correct temperature; properly shaped ladles; cooling the bearing.

It is common practice for railroad passenger and freight-car bearings, after being lined with about $\frac{3}{16}$ in. of babbitt metal, to be bored out in a machine and finished off by hand, but successful results have been recently made by casting a serviceable finished surface from the mold and bedding it directly onto the truck journal.

Some Refrigerating Kinks

By L. A. Lambert

One thing that the average engineer in charge of refrigerating machinery has to learn by experience is to look out for freeze-ups. No matter how many times one is told to look out for this possibility when cold weather comes along, some day sooner or later it will be found that one has overlooked draining some of the water connections, or the condenser, in case it is of the double-pipe or multi-tube type.

This is just what happened in a case where the men had not had much experience with refrigerating machinery. The plant was equipped with a double-pipe condenser, which was placed in an unheated building next to the power house. The place was shut down from Saturday noon until Monday morning every week in the year.

This particular Saturday was a mild day in December. That night the temperature dropped well below freezing, and it kept going down all Sunday until it was about five degrees above zero when night came.

The day fireman and the night watchman, who generally looked after the plant nights and Sundays, gave no thought to the refrigerating machine. They had had sufficient experience to keep the water lines and other piping about the plant from freezing, but supposed that there was nothing about the ice machine that required attention.

Monday morning when the chief came on the job he found about a dozen return bends on the double-pipe condenser either split or broken due to water freezing solid during the night. The windows in the condenser room had been left open for about 36 hours, and the room temperature had been practically the same as the outside temperature during the entire period. Fortunately, none of the inner pipes of the condenser had split.

The writer was installing additional air-cooling equipment at this time in the plant and was called on to recommend some means for getting the condenser into service again at the earliest possible time, as it was necessary to run the machine in connection with some of the manufacturing processes. We removed the return bends from all the stands and with a steam lance thawed out the ice in the ends of the pipes. By using all the good return bends six of the eight stands were reconnected.

A new machine had been installed to take care of an expected increase in the load. The condenser for this machine was of the atmospheric bleeder type and was on top of the building in which the double-pipe condenser was located. Owing to the delay in getting the refrigerating machine started, the superintendent was anxious to make up for lost time, so in order to speed up the work he ordered the second machine started.

When they came to start this machine, they found that the water line to the condenser was frozen solid and the pipe was split in addition. They then tried to run both machines on the double-pipe condenser, but with two stands out of commission the head pressure went up to over 200 pounds even though the machines were still not up to full speed.

After considering a number of schemes, I happened to think of a similar occurrence in another plant. This gave me an idea, so we got several lengths of old hose that had been used for various purposes around the factory. These were cut into convenient lengths and fitted on the inside pipes in place of the return bends. The ends of the hose were fastened in place with wire twisted until it held the hose tight to the pipe. This proved sufficient to permit the usual operating pressure of 25 lb. on the water piping of the condenser, and the two sections were again put in service. The plant was run until new return bends were secured.

Ford Factory Heated Electrically

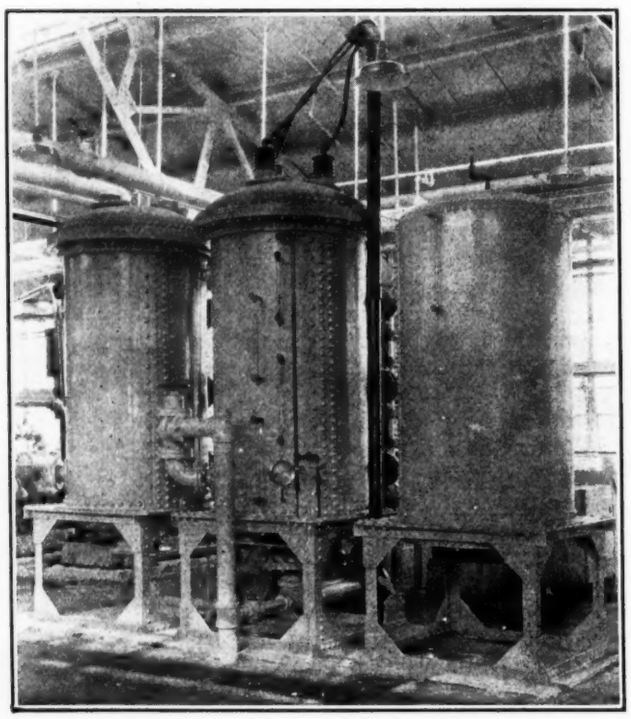
The factory of the Ford Motor Co. at Green Island, N. Y., is heated by hot water which is heated by electricity. The building is 1,140 ft. long, 120 ft. wide and consists of three bays, the two side bays being about 20 ft. in height and the central bay about 35 ft. in height. The outer exposure of this building consists of about 60 per cent of glass; 65,000 sq.ft. of radiation is installed. Water is circulated by motor-driven centrifugal pumps at the rate of 1,500 gal. per min., at a pressure of about 40 lb. The water is circulated through one or two electric heaters, depending upon weather conditions, and is raised to temperature from 135 to about 153 deg. F. The heaters are of the electrode or water-resistance type, having a capacity of 3,200 kw. each, and are operated at 4,600 volts three-phase 60 cycles. The electrical input is controlled by the level of the water in the boiler exactly as in the case of a steam generator and independent of the pump pressure. The change of water level is accomplished by an air column in the heaters, the length of which can be varied at will by admitting or releasing air, which for this purpose is supplied by the compressed-air system of the plant.

The control of power input is, therefore, extremely simple and could be accomplished by thermostatic attachments if desired, but inasmuch as the heaters operate steadily and it is only necessary to change the power input according to outdoor temperature, thermostatic control has not been considered worth while.

The heaters, which were built by the Electric Furnace Construction Co., are specially equipped with baffle

plates to prevent the direct passage of cold water through them. Inasmuch as the heaters are installed in the building to be heated, they are not covered with heat insulation and their efficiency is, of course, 100 per cent. Each heater occupies a floor space only 4 ft. square, and a surge tank occupying an equal amount of floor space is required in order to avoid waste of water when the load on the heaters is reduced; thus only a small amount of water need be added occasionally to make up for leakages from the system.

The advantages of electric heating are cleanliness, minimum of space required and high efficiency. No separate heating plant is required, no fuel storage, ash handling or labor. The heaters require only occasional attention by a janitor or other attendant, who also looks



Electrical heaters on left, surge tank on right

after the circulating pumps and other duties. While the opportunities for the application of electric heating to buildings on a large scale may be limited, yet heaters of this type may be used for water heating, in which case they could be thermostatically controlled to maintain the water at any desired temperature. Even if only the surplus power of a hydro-electric system is employed to heat water or to produce steam, water heaters or steam generators will pay handsome returns on their cost in any cases in the value of the coal saved. The load factor on a system could thus be maintained at practically 100 per cent and the power factor would be favorably affected since the boiler or heater, being a non-inductive load, operates at nearly unity power factor. The cost of the installation is low compared with the cost of fuel-fired equipment of equal capacity, and the cost of operation often is practically nothing when the electric heaters or boilers can be put in charge of a regular boiler-room crew.

It is of record that shortly after the close of the Civil War two-thirds of the industrial power of New England was hydraulic.

Steam Boilers

A Catechism by Warren Hilliary Served in Small Doses and Extending Over a Number of Issues

1. What is an internally fired boiler?

A boiler having an internally constructed furnace which forms a part of the boiler itself.

2. What is a dry-back boiler?

An internally fired boiler the rear head of which is formed by the tube sheet and which has no water space at the rear of the tube sheet.

3. What is a wet-back boiler?

An internally fired boiler the combustion chamber of which is surrounded by water.

4. Why are internally fired boiler furnaces, sometimes corrugated?

To allow a comparatively free expansion and contraction, longitudinally.

5. Do corrugations run circumferentially or longitudinally?

Circumferentially.

6. Why?

To permit the free expansion and contraction of the metal and thus prevent the setting up of dangerous stresses in the metal.

7. Where should the furnace seams be located?

It is best to locate them below the grate bars.

8. Why?

The placing of the seam below the grate bars will lessen the possibilitiy of leakage, which might otherwise be caused by the flames coming in contact with the seam. In oil-burning installations, however, grate bars are not used, and the temperature at a given point on the inner circumference of the furnace is so nearly uniform that leakage of the seams is not likely to occur. Hence, in the case of oil-burning furnaces the placing of the seam at any particular point in the furnace is unimportant.

9. How are internal furnaces secured to the rear furnace sheet?

There are two methods:

a. When the furnace at the external apex of the corrugations is equal in diameter to the ends, these are straight and are single-riveted to the inner faces of the front and rear heads, the heads being flanged inward to receive the straight ends of the furnace. With this construction the diameters of the furnace openings in each head are equal.

b. When the rear end of the furnace is flanged and faces the inner side of the unflanged rear head, it is customary to double rivet the seam. In this case the rear end opening of the furnace is smaller in diameter than the furnace at the external apex of the corrugations, and consequently, smaller than the furnace opening in the front head. This construction is rarely used except in wet-back installations.

10. How are internal furnaces fastened to the front furnace sheet?

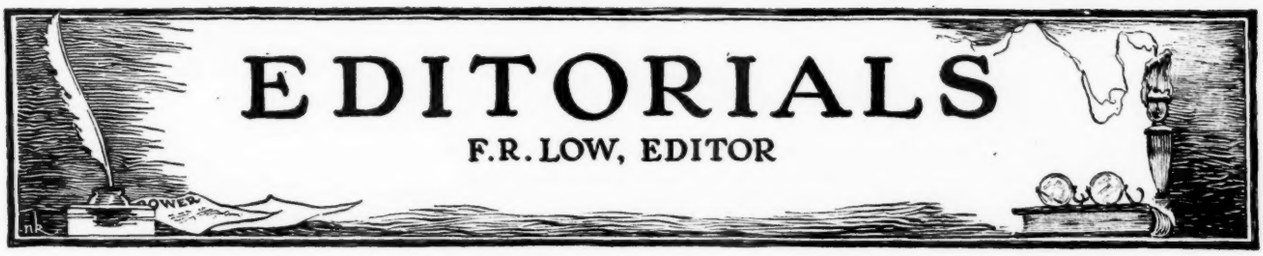
The forward end of the furnace is straight and is single-riveted to the front head flange.

11. Where should the fusible plug be located in a wet-back internally fired boiler?

At the top center of the combustion chamber.

12. Where in a dry-back boiler?

The center of the plug must be at least two inches above the tops of the upper row of tubes and at the greatest possible distance from any neighboring opening made in the head for tubes or through stays.



Governor Smith's Proposal

TWO factions have long hindered water-power development in New York State—those who have insisted upon promotion by private capital and those who have stood for state development. The proponents of state initiative have lacked organization and method and have never been able to put forward a workable plan for financing. Political observers have stood aghast at asking the people to provide a half billion dollar bond issue, the amount estimated as necessary for a comprehensive state-wide development. Therefore, the proposal of Governor Smith to deal with the situation through the creation of a corporation empowered to issue bonds for its working capital, would obviate the necessity of a referendum to the people, and offers a unique solution to the problem that will be welcomed by those favoring state ownership.

Whether the plan in its practical operation would be as simple as might appear at first glance, is a matter to be carefully considered. It would seem that the chief difficulty will lay in the financing. Who would be most likely to purchase the bonds, unsecured by state credit, in an untried venture even though it might offer most promising potentialities? It is unlikely that the banks, insurance companies and other investment agencies would be attracted to such a proposal, especially where there was no provision for investment representation in the management. It might be that the general public would be willing to subscribe, but a large amount is involved, and the average man desires immediate or early return on his investment, whereas a considerable period must necessarily elapse before such projects could be developed and become going concerns.

Other questions are likely to rise and will have to be met before a truly workable plan can be evolved. The fate of the proposal will rest with the legislature, and is likely to be determined by political expediency. The essential point is that a concrete suggestion has been offered in the place of generalities such as have heretofore been much discussed.

Combating the Peak

THE season is now well advanced when lighting and power loads overlap, entailing additional operating problems due to the superimposed peaks. Usually, this means higher rates of combustion and evaporation, banked fires and more rapid wear and tear of the boiler-room equipment. In most industrial plants these matters are less pressing than in the central stations, but in the former where overlapping of power and lighting loads exists for the entire working day during dark weather, it is often the voltage regulation that works havoc with production and creates problems all along the line.

Illumination varies radically with the voltage, and the torque of an induction motor varies approximately as the square of the voltage. So it can be seen that a decrease in voltage lessens not only the illumination, but also the torque produced by the motors. Inadequate light produces fatigued and less efficient workers, and at reduced voltage the motors come up to speed more slowly and require a heavier current. So the effect is cumulative.

Moreover, it may be found that the total load is beyond plant capacity. This condition is often aggravated by the starting of large cranes with heavy loads, large compressors and other forms of load simultaneously, each taking a heavier current than normally. Low power factor helps to make conditions worse. The sudden, short-lived heavy current swings due to starting heavy loads may not noticeably affect the steam pressure, but they do disturb voltage regulation as well as individual machine performance.

It is at this time of year, therefore, that the portable recording instruments—watt-meters, voltmeters, ammeters and power-factor meters—are such a boon. Any one of these instruments may more than pay for itself in a day. They have often done so by indicating the remedy through modifying the method of operation instead of installing additional generating equipment or copper.

The recording electrical instrument shows what is going on every instant of the time it is in the circuit. The sudden surge; the starting of two or more machines simultaneously; the careless handling of a controller; the machine allowed to run idle; the man who quits before it is time or who lies down on the job to prepare for lunch; no-load and frictional losses—these and a hundred and one other conditions are brought to light. Its records make diagnosis of otherwise complex conditions quite simple. It enables one to differentiate between cause and effect, so saving time and money in applying the remedy.

Too Old at Forty?

FIFTEEN or twenty years ago Dr. William Osler remarked in public that a man ought to be chloroformed when he reached the age of sixty. Doctor Osler later characterized this statement as a joke and himself lived far beyond the allotted limit without objecting. Yet the statement was not forgotten, and many defenders rose up for the man over sixty.

If there is much to be said for the genuine usefulness of men over sixty, one would hardly imagine that the relatively tender age of forty would be even under suspicion. Yet such is the case. It happened only recently that a competent and experienced engineer applied for a position on the staff of a large central station. He was found to be acceptable in every way except one. He had passed his fortieth birthday by a year or two! The rules of the company did not permit taking on a man of his age.

Knowing the years of experience required to become a competent operating man, the average engineer, even where he himself is safely under forty, will question the wisdom and justice of such a rule. He will think it a funny world where a man is ruled out for "old age" just about the time he begins to know something.

Considering the question calmly, it is evident that the management promulgating such a rule must be doing so for a real or imagined business reason. Perhaps this reason is based on the common observation that as a man grows older it is harder for him to learn new things. Obviously, a forty-year-old merchant would have a stormy time ahead if he started out to become a first-class operating engineer. The trained operating engineer of forty would have as bad a time, or worse, if he tried to run a department store.

But the case at hand is entirely different. It is not a question of entering a new line of work, but of an experienced man continuing the same line of work in another plant. There is a fundamental simularity in power plants, particularly in steam-operated plants. The qualities that make an engineer valuable on his present job should have similar value in another plant. If engineers over forty are worth keeping, they should also be worth accepting as new employees.

It is a well-known fact that a large percentage of the most capable operating engineers are men over forty. Ability to turn handsprings and "skin the cat" is of little help in operating a plant. Judgment, reliability, common sense, knowledge, practical experience, executive ability—these are the big factors in an engineer's value, and they are factors that normally continue to develop far beyond the fortieth milestone.

It is not contended that every engineer over forty is worth hiring. There is a certain type of man that seems inevitably to fall into a rut—a rut that grows deeper the older he gets. But just as often the man of forty-five, and sometimes the man of sixty-five as well, has all the openmindedness and initiative of youth, reinforced by knowledge and experience and tempered with seasoned judgment. Why should such a man cease to be in demand merely because he has passed forty?

Lowering the Cost of Power not the Only Consideration

WITH the introduction of the electric generator the universality of power was made possible. From the use in factories built close to the power source, before electrical transmission and distribution became a reality, the use of power has spread into every human activity. The universal use of power has brought the public into close contact with the problems of power supply, and as a result the discussion of this subject is no longer confined to engineers and their associates, but has become of general interest among laymen. Unfortunately this discussion is frequently based on distorted ideas for which engineers and others familiar with the subject are in a way responsible. Even among engineers perverse thinking concerning power supply and cost is by no means conspicuous by its absence.

The idea of superpower has been used in such a way as to lead those not familiar with it to look for vastly more than can ever be expected even by its most enthusiastic advocates. The way this term has been applied by newspaper writers, opportunists and others, has led the general public to believe that power costs are going to be greatly reduced. No doubt the interconnection of power systems will result in a reduction in power costs if the depreciated value of the dollar is considered. But this is not the way the power user looks at it. To the average purchaser a dollar is one hundred cents, whether it is actually worth sixty or something else when compared with some previous standard. Power costs have remained practically constant—that is, the number of cents paid for a kilowatt-hour—for a number of years past, but everything that goes into power production has been increasing in value, therefore the equivalent of a substantial reduction in cost has been obtained.

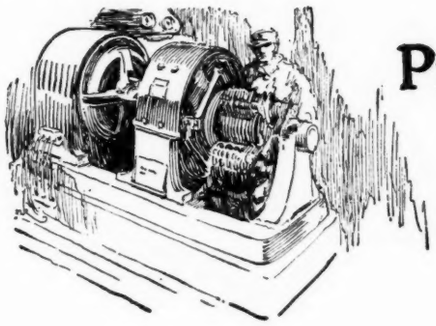
Interconnection of power developments into so-called superpower systems does result in economic advantages as already demonstrated in various sections of the country. It makes possible a better and more reliable service with less reserve capacity. By the interconnection of power systems over wide areas, supplied largely from water powers, it has been found that advantage can be taken of the diversity of run-off of the different watersheds. Power can be transmitted from a district where there may be a surplus of water into one of low water. Generation is a small part of the total cost of supplying the small consumer, and it is frequently the expense of transmission and distribution that keeps power at reasonable rates outside the reach of sparsely settled districts. As the networks of transmission lines spread over the country, it makes possible a wider use of electric power for all purposes. Electrification of the railroads, greater use of our water powers, generation of power in large economical steam stations, all of which will result in enormous coal saving, will be made easier to realize by the interconnection of our power systems.

Probably the economic advantages of interconnection of power systems are not as yet fully realized, but great as these are they do not necessarily mean an actual reduction in the cost of power. However, even if the present trend in power development does not result in a reduction in cost to the ultimate consumer, the many other advantages show it to be economically sound and a natural outgrowth of the modern methods of power generation and distribution. On the other hand, if the engineers are to avoid disappointing power users in what is to be expected of superpower, the facts must be set forth in unmistakable terms.

Fuel Efficiency Tests

THE results from tests carried on at the Navy Fuel Oil Test Plant and from tests made by the United States Shipping Board show that it is entirely feasible to obtain with oil-fired boilers efficiencies from eighty to eighty-five per cent. In practice, however, investigations show that the efficiency obtained in average practice is seventy per cent or less, although in a number of cases where the fuel problem has been thoroughly attacked, the vessels show approximately eighty per cent boiler efficiency.

Experience shows that the chief factor affecting boiler efficiency in installations fitted with any one of the recognized burner equipments, is the efficiency of the personnel, and it is for this reason that the importance of training and educating the operating personnel in the art of oil burning and in the handling of fuel should be given special attention.

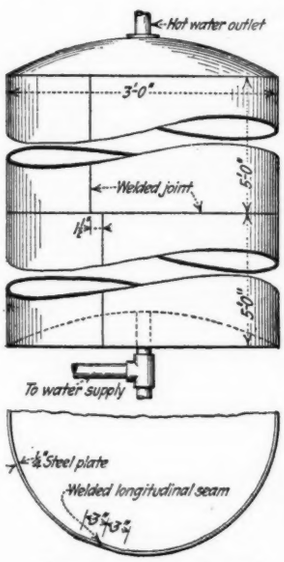


Practical Ideas *from* Practical Men

An Example of Faulty Tank Construction

The illustration shows the general construction of a welded tank that is installed in a local building. The tank serves as a storage for hot water and has an exhaust steam heater connected to it, but not shown in the sketch.

Water is supplied to the tank from the service main in the building, the connection being taken off near the end of the line. All cold-water outlets are taken from the same main. The heaviest demand made on the system is that due to the use of automatic flush valves. It so happens that the sizes of pipe used are such that the opening of one of the flush valves reduces the pressure in the system several pounds. The quick closure of these valves results in a surge of several pounds above the normal static pressure.



Construction of tank with welded seams

In bending up the sheets for the tank the edges of the plates were not truly circular, but were tangents to the nominal circular section. The result of this condition is a tank with a flat strip about three inches wide on each side of the longitudinal seams. The result of this condition is that the tendency of the section is to become truly circular under pressure.

Some readings of this deflection were taken by means of an Ames dial indicator. The indicator was mounted rigidly and set to zero when in contact with the tank at a point near the welded seam. The needle of the gage was continually moving owing to variation in pressure in the main outside of the building. Readings taken when one of the flush valves were operated were as follows:

Static pressure 55 lb. per sq.in., dial reading 0.000-in.; valve open, pressure 32 lb., dial reading minus 0.035-in.; valve closed, surge pressure 69 lb., dial reading plus 0.012-in.

Any variation in pressure as large as noted is always accompanied by an audible sound and a visible deflection of the shell. If this joint were of the riveted type, the increased stiffness would no doubt greatly reduce this value. The theoretical decrease in radius for the drop in pressure noted is about 0.0018 inch.

Springdale, Pa. R. B. BOALS.

Presence of Mind in the Power Plant

Although we have done a good deal in recent years toward making everything as safe as possible, "accidents will happen," some of which could easily have been avoided by the display of a little presence of mind when the emergency arose, and one who lacks this important characteristic, no matter how great his qualifications in other directions, is a dangerous man around a power plant.

A few days ago in our plant a small main-drive belt suddenly collapsed, and the attendant immediately rushed for the engineer; had he hesitated for about two seconds and meantime given a handwheel a couple of turns, it would have saved considerable expense in replacing a partition that happened to be near by.

Discussing this matter with the Government Inspector, he informed me that of six recent accidents involving injury and in two cases loss of life, which he had investigated, in four cases a little presence of mind would have made them minor affairs, and he considered this qualification a most important one for all men engaged around moving machinery. Unfortunately, we have no reliable means of determining whether an applicant for a position possesses the necessary nerve in moments of emergency, but I have usually found that irritable persons who lose their tempers easily and the absent-minded type are failures in this direction, while the majority of men who have "sea experience" are the most reliable. This, no doubt, is due to the nature of the work they have to do when, as most of us know, there are occasions when they have to display nerves of steel while cooped up in an engine room, not knowing what will happen next, and, as one old veteran explained to me, "with never a thought of leaving their post until the ring through appears on the dial. Sometimes this is forgotten, and a few more engineers appear in the casualty list, but thousands of lives have been saved." Everyone admires the traditions of these engineers, and if we could instill the same kind into everyone who enters a power plant, many accidents would be avoided.

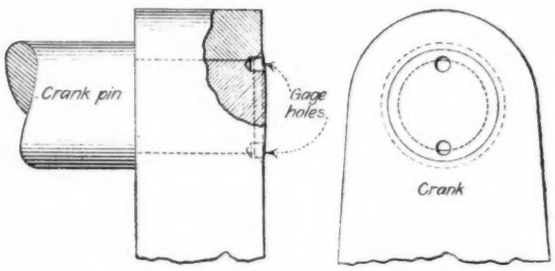
I believe that much more could be done to improve affairs by giving greater publicity in our journals and our engineering societies to the number of accidents that are avoided by the display of presence of mind and greater publicity still to the ones that are not avoided but might have been. We expect all men who are sea engineers, members of fire brigades and other like services to possess nerve, and if we cannot include engineers and attendants in power plants in the same category, it is our own fault. Many of the men engaged in this work would welcome some sort of a test for nerve and presence of mind as part of the necessary qualifications for any post in a power plant or even making the lack of it in cases of emergency a criminal offense. If

Many acts of bravery worthy of great honor have been done in the engine room and power plant. Let us give these deeds greater publicity and then instil into the mind of every plant engineer that he has something to live up to and that in this profession there is no place for the wavering kind of individual. F. P. TERRY.

Belfast, Ireland.

Determining Diameter of Crankpin While in Place

On an old 18x36-in. Corliss engine the crankpin had become badly worn and it was decided to replace it. To remove the pin and wait for a new one to be made would require several days, and the engine could not be spared that long. The outside dimensions of the



Holes were drilled in pin and diameter then measured with dividers

pin could be easily taken, but it required some investigating to determine the correct diameter of the part that extended through the disk. The pin shouldered against the face of the crank-disk and was riveted into the countersink at the back of the disk. Accordingly, a portion of the riveting was cut away and two small holes were drilled in the pin, diametrically opposite, as shown in the illustration. The diameter of the hole could then be calipered with a pair of dividers. The new pin was then ordered from these measurements, and the engine continued to give service until the new pin arrived. On a Sunday the riveting was cut away and the pin driven out. Then the new one, after being well lubricated with white lead, was forced in with a hydraulic jack and the end riveted over.

Utica, N. Y. M. M. BROWN.

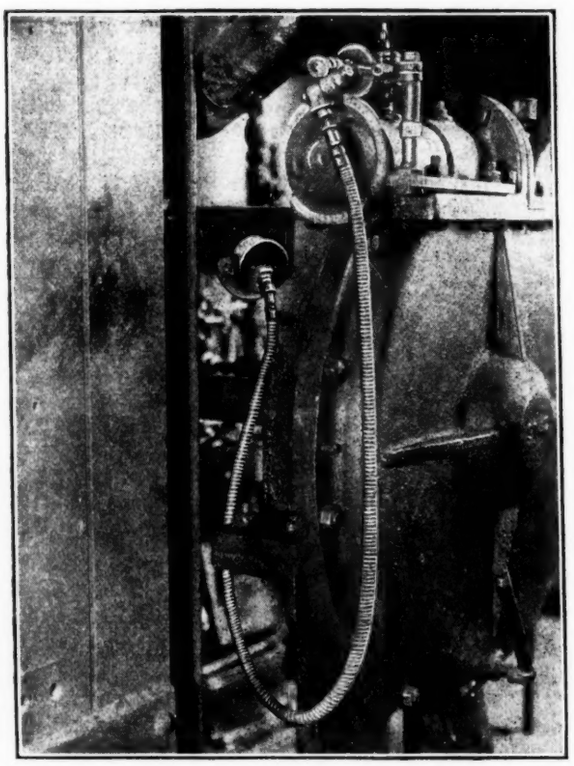
Ford Speedometer for Indicating and Recording Stoker Speed

In the operation of our boiler plant, consisting of eight 6,000-sq.ft. water-tube boilers fired with forced-draft chain-grate stokers, we realized the importance of a speed indicator that would indicate and record the speed of the chain grate, but did not know of any instrument that would do this and that could be purchased and installed on each boiler at a reasonable cost.

Recently, we bought a Ford automobile speedometer and installed it on the stoker as shown in the illustration. The ordinary sprocket wheel was mounted on the transmission wormshaft of the stoker-driving mechanism, and the speedometer was placed near the throttle valve of the engine driving the stoker.

This apparatus will improve the efficiency of the boiler-room operation in several ways: First by showing a comparative indicated speed of the stoker chain; second, the total feet that the chain travels per hour or shift or day can be determined from the speedometer readings; third, with the same grate setting on each boiler and using same kind of coal, it will be possible to check approximately the pounds of coal used for the speedometer readings, comparing one boiler's operation with another; fourth, speedometer readings would also be used in installing an oiling or maintenance system; fifth, by noting the indicated speed of the stokers and the output of the steam-flow meters and comparing the operation of one boiler with another, the operation of the stoker will be improved and better efficiency will be obtained; sixth, with a fixed fuel-grate setting the same size and kind of coal, the slower the fireman can operate his grate for a given load the better economy he will make, and by having an instrument that will indicate the stoker speed he can make such changes in the stoker operation to maintain the lowest speed for a given load; seventh, the indicated speed of the stoker will be of value in overhauling the turbine or engine governors by showing the speed variation of the engines or turbines driving the stoker.

The advantage of using a Ford speedometer for this purpose is the low purchase cost, the low cost of in-



Shows method of installing speedometer on stoker

stalling and of repair parts; also as these speedometers and repair parts can be bought in almost any city, it is not necessary to carry extra parts or have the instruments out of service waiting for repairs.

El Paso, Tex. CHARLES LEARMOUTH,
Chief Engineer, El Paso Electric Railway Co.

With 2 per cent of the area and 7 per cent of the population of the United States in 1919, New England had 15 per cent of the wage earners, used 13 per cent of the industrial power and in value made 11½ per cent of the products.

Comments from Readers

The Loneliness of the Veteran Engineer

I read with interest the remarks of Mr. Odell, in the Nov. 6, 1923, issue, and it appeared to me that much of the neglect of which he speaks is due to want of thought, not only by the younger generation, but by many who are bordering on the veteran stage themselves. It may not be possible individually to render financial help to the distressed, but we can all offer a friendly word or chat about old times.

A few doors from me an old veteran of eighty-seven is living with his daughter. He retired at eighty from the position of chief engineer of a large industrial concern on a pension which removed all fear of want. For the last five years I have managed to spend at least one hour a week in his company, and we talk nothing but "shop," often, I fear, to the annoyance of other members of the family. He talks of bygone days and men, a subject that is always interesting to me. I keep him posted on present-day affairs in the power field, and these visits mean much to him.

No doubt this loneliness is the bugbear of many of our veterans, and as Mr. Odell says, while giving a friendly hand and smile to the younger generation, each one of us can act likewise with the old boys without loss of prestige.

F. P. TERRY.

Belfast, Ireland.

Unaflow Engines with Dual Clearance

In *Power*, Oct. 30, 1923, Duncan A. Morton made some comments upon the dual-clearance engine and piston valves. Having a converted engine of this type in daily operation, I have personal experience as to its merits.

This engine originally had a partly balanced slide valve, but required a quart of the best cylinder oil every two days to keep it properly lubricated. This oil caused trouble in the boiler when using the exhaust steam for heating. Furthermore, it did not govern well on a variable electric-elevator load, owing to unbalanced pressure on the slide valve, which was operated by a shaft governor.

To improve the engine, I equipped it with a self-adjusting piston valve of my own make and so reduced the oil consumption 70 per cent. The speed regulation was also improved, since the governor had less work to do. It operated this way satisfactorily for ten years. Over a year ago we decided to improve the economy of this engine by putting on a unaflow cylinder with dual clearance. We are well pleased with the results. It is easy to take care of, runs quietly, does 30 per cent more work on the same consumption of coal and has paid for the change in a year. The piston valve, being equipped with self-expanding packing rings, remains tight, as tests at regular intervals have proved.

How the economy of this engine compares with other makes I am unable to state, not having the facilities for an economy test, but I know that the one that we have in operation is at least one-third more economical than a plain slide valve.

If, as Mr. Morton states, the piston valve is the refuge of the destitute, why do modern locomotives working on 200-lb. steam pressure use nothing but piston valves? He may have had in mind the old-style solid piston valve. When properly made, piston valves with self-adjusting packing rings remain tight and give no regulation trouble when the engine operates at light or friction load even though full boiler pressure be carried, with the throttle valve wide open.

New York City. CHARLES KOSTER.

Grooving the Pulley To Prevent Belt Slippage

I read with interest the article by H. Lawrence in the Dec. 11, 1923, issue, "Grooving the Pulley To Prevent Belt Slippage."

There is one important point about his method, however, which I disapprove, and that is the cutting of the grooves parallel with the shaft. By cutting the grooves in that way, the pulley is weakened much more than would have been the case had they been cut circumferentially. When a pulley bursts owing to centrifugal force, the rupture usually follows a line parallel with the shaft and not circumferential with the pulley. Therefore, when grooving a pulley it is not good engineering practice to weaken it along its line of least resistance, as he has done.

The strength would not be impaired so much if the grooves had been staggered instead of making two grooves end to end and both in a straight line.

It is much easier to groove a pulley circumferentially. Simply place the pulley in a lathe, and the groove can be made with a singe cut of a lathe tool. By grooving parallel with the shaft, as was done by Mr. Lawrence, much more time is required and it is questionable in my opinion whether as good results could possibly be obtained in that way as by using the continuous cut or groove around the pulley. I know of at least one manufacturer who makes a pulley with this circumferential groove already in it, and it is my understanding that that type of grooved pulley never gives any trouble due to entrapped air and belts do not run off unless there is something radically wrong with them or the shafting is badly out of line.

L. W. LOWERRE.

Elizabeth, N. J.

Retubing Boilers with Bulged Heads

I read with interest the article by R. A. Cultra in the Dec. 18, 1923, issue on "Retubing Boilers with Bulged Heads." I do not think that a slight bulge in the boiler head is as serious as his article might lead one to believe.

Our method of renewing tubes is first to measure the length of the tubes in various parts of the head and then order tubes for the greatest length. When putting them in place, we expand the rear end first, then take a cold chisel and trim them off to the right length in the smoke-box end and expand and head them over.

Probably no boiler head is true when new, so why

worry over a lack of truth in an old one? It probably does not affect the safety or efficiency of the boiler in any way. As to removing tubes, about the quickest and best way is to cut them off inside the head with an oxyacetylene torch.

It is my opinion that most tubes in return-tubular boilers are rolled too much. We have four 2,000-sq.ft. return-tubular boilers that have been in service over nineteen years without removing a tube and there has been only a little tube leakage in one of them, due, as far as we were able to make out, to burning wood shavings in it occasionally. This leakage we have usually remedied by calking; if the expander was used, it was only lightly.

There is considerable difference of opinion as to the relative merits of the different types of stays in this class of boiler. I have, during forty years' experience in operation, reasoned it out this way, that the shell is longer when the boiler is operating, thereby either stretching the braces or drawing the heads closer together, so that when looking at them cold the braces are slack. The braces in our nineteen-year old boilers have shown slack since shortly after these boilers were placed in service, but we are satisfied that when they are in service the through braces are doing their full duty.

Anderson, Ind. J. O. BENEFIEL.

An Old-Time Engine Still in Service

I was much interested in the series of articles by Mr. Odell entitled, "Reminiscences of a Veteran Mechanical Engineer," and especially so in the discussion that followed relating to early makes of Corliss engines. Fig. 1 shows an old timer that is still in operation driving the plant of the Wilson Box Co. at St. John, N.B. It is a 20½-in. cylinder by 48-in. stroke running at 73 r.p.m. The engine is a very old one, the builder's

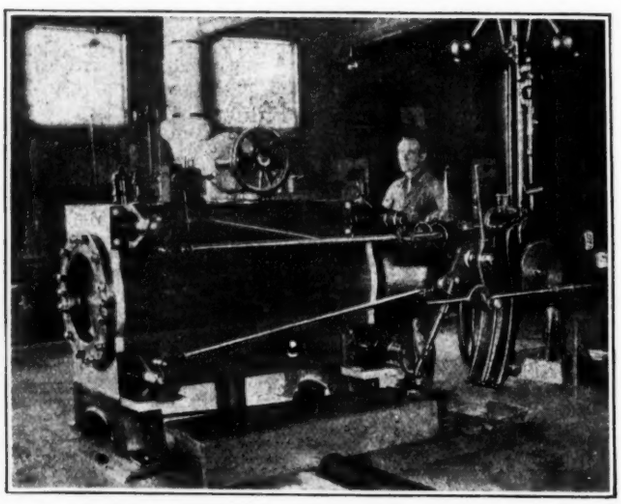


Fig. 1—An old timer still in service

name-plate had been taken off before it was installed here thirteen years ago. It will be seen that the engine is fitted with the old-time spring-lever type of valve gear. There is a small plate on the governor bearing the name of A. J. Allen, Hope, R. I., patented June, 1885. I would like to learn from some reader of *Power* if Mr. Allen built engines of that type, or has the original governor been replaced with an Allen governor of a later date? At any rate both governor and valve gear are a novelty. The eccentric is placed 90 deg. behind the crank with a one-piece rod 13 ft. long from eccentric to wristplate. The engine runs 54 hours a week the year round and has had no repairs since coming here. It has about all the load it will carry with a boiler pressure of 110 lb. gage (running non-condensing) owing to the early cutoff. The indicator diagram shown in Fig. 2 was taken with 3 or 4 lb. back pressure, as the exhaust is

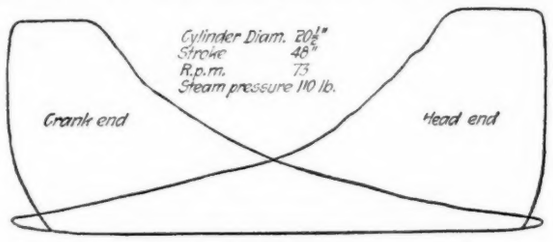


Fig. 2—A recent indicator diagram obtained from engine

used for heating. We plan on having the cylinder rebored in the near future and fitted with a new piston and rod. When that work is completed, I believe the engine will be good for many more years of service.

Undoubtedly, some of the veteran engineers will be interested to know that there is at least one of that type of engine still running and doing good work.

St. John, N. B., Canada. ROY B. LONGARD.

Referring to the article in the Oct. 30, 1923, issue of *Power*, by Frank Richards, on old-time engines, I will say that in or about the year 1886 there was a boat in the Passaic river that was equipped with an engine similar to the one Mr. Richards describes. I believe that it was known as the Bordentown Engine. This boat lay for some time at the dock of the old Ackerman sawmills, at Passaic, N. J. GEO. J. LITTLE.

Hasbrouck Heights, N. J.

Phasing Out Generators for Parallel Connection

Referring to questions of E. C. Curtis in the issue of Nov. 27, 1923, the following comments may be of assistance:

It is asumed that the manufacturing plant in question generates all its own energy so that it will not be necessary to synchronize with the bus and it can therefore be done between generators. Only the actual connections needed are shown. Fig. 1 shows a method of phasing out machines by means of voltage (potential) transformers and lamps. There will be required four voltage transformers T_1, T_2, T_3 and T_4, having a ratio of 2,300 to 110 volts, and four 110-volt lamps. The lamps and transformers should be connected as shown, care being taken to connect two lights in series. If voltage transformers are not available, small lighting transformers may be used, care being taken that they have the same general characteristics. With the connections made as indicated, proceed as follows:

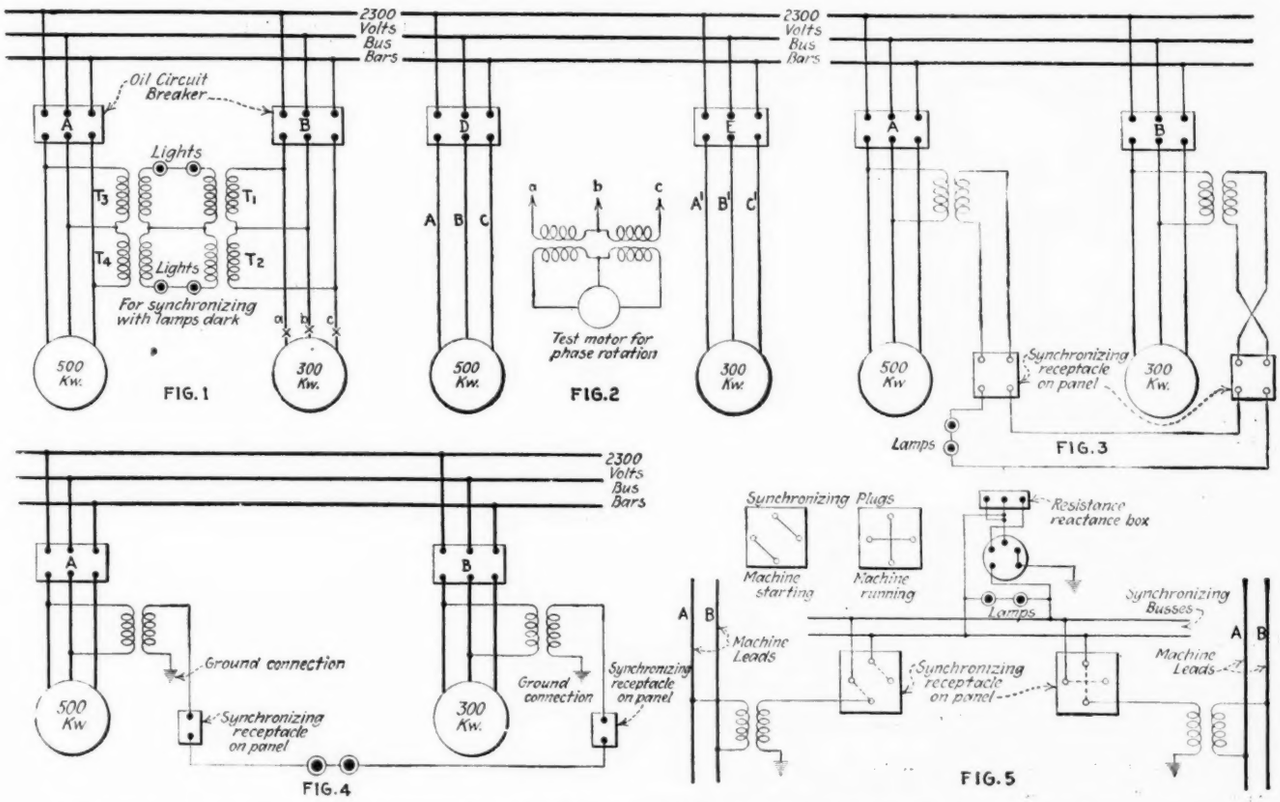
Disconnect terminals of 300-kw. machine *a*, *b*, *c* at *X* and close oil circuit breaker *B*. This will duplicate conditions as they exist under actual running conditions. Note the condition of the lights; they will either burn at normal brightness or be dark or a combination of bright and dark. Since the usual method for synchronizing with lamps is by the dark method, the connections of the

2,300-volt leads of the voltage transformers connected to the 300-kw. machine, should be changed until all the lamps are dark. The terminals of the 300-kw. machine should now be connected again and oil circuit breaker *B* left open. With both machines running at approximately normal voltage and speed, note whether the lamps all go dark at the same time. If they do not, interchange two of the 300-kw. machine leads, say *a* and *b*, and make another test. If the conditions are now correct, all the lamps will light up and go dark together, and when the speed and voltage of the machines are properly adjusted the lamps will remain dark, indicating that the machines are in phase and in synchronism. Breaker *B* may now be closed and adjustments made to divide the load and the necessary field rheostat adjustment to reduce the machine current to a minimum total for the two machines.

Fig. 2 shows a method of phasing out by means of a three-phase motor. The leads to both machines should be tagged *A*, *B*, *C* and *A'*, *B'*, *C'* and the motor transtransformer leads *a*, *b* and *c*, as indicated. Connect leads *a*, *b* and *c* to *A*, *B* and *C* and note direction of rotation; transfer *a*, *b* and *c* to *A'*, *B'* and *C'* with breaker *E* open and again note direction of rotation. If the phasing is correct, the motor will revolve in the same direction with both connections; if the phasing is wrong, the motor will reverse its rotation with the second set of connections. Should the phasing be wrong, reverse two of the leads of the 300-kw. machine, say *A'* and *B'*, and test again. If the rotation of the test motor is now the same, the machines are ready to be synchronized. Another method would be to connect the motor to the busbars without any load on the system, then close the switch on the 500-kw. machine and note the direction of the motor rotation. Next open the switch on the 500-kw. machine and close the 300-kw. unit to the bus; if the motor rotates in the same direction in both cases, the machines have a correct phase relation.

Figs. 3 and 4 show the permanent connections for synchronizing with lamps dark at synchronism. The essential difference in the two diagrams is the method of connecting the secondaries of the voltage transformers. In Fig. 3 the secondary leads are both used, requiring a four-point receptacle on the switchboard panel; in Fig. 4 one of the secondary leads is grounded and only a two-point receptacle is required on the panel. It is usually customary as well as advisable to protect the operator by grounding the secondaries.

The method of synchronizing machines by means of



Figs. 1 to 5—Diagrams of connections for phasing out and connecting alternating-current generators in parallel

lamps is reasonably satisfactory if care is used by the operator. It is better, however, to install a synchronism indicator as well as lamps if it can be done. With lamps only it is difficult if not impossible to judge whether the incoming machine is revolving too fast or too slow, while with the indicator it is possible to tell instantly whether the speed is high or low.

Fig. 5 shows the general connections for a conventional type of synchronism indicator. Lamps are generally also installed to be available should any trouble occur in the indicator, thus allowing another method of synchronizing under emergency conditions. Should the wrong plug be inserted in a receptacle—that is, the "machine running plug" be inserted in the receptacle of the machine being synchronized—the indicator will register incorrectly and will indicate that the machine is fast when it should be slow. This error is readily detected, however, when it is attempted to adjust the speed of the incoming machine.

New York City. C. OTTO VON DANNENBERG.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Paste for Gasoline Pipe Joints

What can be used in place of a material like red lead for making tight joints in piping connected with a gasoline tank? L. J.

Pipe joints for gasoline at ordinary atmospheric temperatures can be made up tight by first filling between the screw threads of the pipe with a thin paste made of gum shellac dissolved in a 10 per cent solution of ammonia. The screw threads of both pipe and fittings should be thoroughly cleaned of grease before application of the paste.

Disadvantage of Feeding Through Heater by Injector in Place of Pump

We have a small closed heater that is supplied with exhaust steam from the engine for heating boiler-feed water that is delivered by a steam pump through the heater. As an auxiliary feeder there is an injector which discharges directly into the boiler. Would there be any gain by feeding with the injector through the heater? E. P. A.

For the generation of steam at a given pressure the relative economy would depend on the initial temperature of the feed water, the temperature attained by the feed water when using the pump and the amount of steam chargeable to the pump, with due credit for heat recovered from the pump exhaust, and also would depend on the temperature of the feed water delivered to the boiler with the injector discharging through the heater.

Assuming that steam is generated at 100 lb. gage pressure, or 115 lb. per sq.in. absolute, then each pound of steam generated would contain 1,188.8 B.t.u. above 32 deg. F. If the temperature of the feed water is raised to 200 deg. F. when using the pump, the evaporation of each pound of feed water as delivered by the heater would require 1,188.8 + 32 — 200 = 1,020.8 B.t.u. Operation of the steam pump would require about 3 per cent of the steam generated, so that each pound of steam delivered for other purposes would be taxed with 3 per cent of 1,020.8, or 30.6, B.t.u. and therefore would cost 1,020.8 + 30.6 = 1,051.4 B.t.u.

When using the injector, the steam required for its operation would be returned to the heater as condensate along with the feed water at the temperature of about 150 deg. F. and both would be discharged from the heater at somewhat higher temperature than when the pump is used, or about 210 deg. F. If the initial temperature of the feed water is 50 deg. F., then in place of the heater raising the temperature from 50 to 200 deg. F. or delivering 150 B.t.u. to each pound of the feed water, as when using the pump, the heat realized from the heater when using the injector would be only 210 — 150 = 60 B.t.u. per pound of feed water, so that each pound of feed water evaporated into steam at 100 lb. gage would require 1,188.8 + 32 — 60 = 1,160.8 B.t.u. as against 1,051.4 B.t.u. required of the boiler for each pound of steam utilized beyond that required by the pump when the pump is used. Hence, under the assumed conditions there would be a loss from the use of the injector in place of the pump of (1,160 — 1,051.4) ÷ 1,051.4 = about 9 per cent.

Water Carried Over to Engine With Higher Boiler Pressure

We have a 72-in. by 18-ft. h.r.t. boiler for supplying our engine and laundry machinery with live steam. With two gages of water in the boiler, when carrying 100 lb. pressure we are troubled with water going over to the engine, causing it to knock. No such trouble occurs with higher water in the boiler when the pressure is 75 to 80 lb. The steam header from which the supply of live steam is drawn is provided with a trap for drainage, and there is a separator with a discharge trap in the branch to the engine. How is the trouble of water carried over to the engine to be accounted for? C. C.

It may be that the boiler foams when higher pressure is carried from more active firing; or the traps may not operate properly with the higher pressure. Bleeding the traps would demonstrate if they are at fault. If the trouble continues when the trap connections are bled, and a glass water gage on the separator does not show flooding of the separator at times when water is carried over to the engine, the conditions would indicat that the seperator is not working properly. Most separators depend for their operation mainly on the velocity of the steam. At 100 lb. gage the density of the steam would be about 25 per cent greater, and for the same engine load the velocity of the steam swept through the separator would be about 20 per cent less, than when the steam is 75 lb. gage. The separator may operate less efficiently at the higher pressure, and that may be the principal cause of trouble from water being carried over to the engine when there is higher boiler pressure. The lower pressure conditions and better operation of the separator can be obtained by throttling the steam before it enters the separator.

Conversion of Boiler Shells Into Water Heaters

We wish to convert two 66-in. by 16-ft. boiler shells into closed heaters with iron steam-pipe coils to heat 200,000 gal. of water in four hours, with a temperature rise of 150 deg. F., using steam at 100 lb. boiler pressure. How many feet of pipe surface and how much steam would be required? J. E. B.

The amount of pipe surface required would depend on

the initial as well as the final temperature of the water, the condition of the surface, whether coated with grease or scale, and also the velocity of the water over the surface. Where W = pounds of water heated per hour, A = area of pipe surface in square feet, T_s = temperature of the steam, I = initial temperature of the water, and F = final temperature of the water, the pipe surface required is given in square feet by the equation,

$$(1) \qquad AU = W \log_e \frac{T_s - I}{T_s - F}$$

For submerged steam coils of iron pipe, the condensation being removed as rapidly as it forms, the value of U for a mean temperature difference between the temperatures of the steam and water of 50 deg. F. may be taken as 100; for 100 deg., 175; for 150 deg. 200; and for 200 deg., 225.

As an example of application of the formula, assume I, the initial temperature of the water, to be 50 deg. F., then for a rise of 150 deg. F. the final temperature would be 200 deg. F. The mean temperature of the water would be $(50 + 200) \div 2 = 175$ deg. F., and as the temperature of steam at 100 lb. gage is 338 deg. F., the mean temperature difference between the steam and water heated would be $338 - 175 = 163$ deg. F., which would give a value for U in the formula of about 206.

As 200,000 gal. of water heated in four hours would be 50,000 gal., or about $50{,}000 \times 8\frac{1}{3} = 416{,}666$ lb., of water per hour, for the conditions,

$$\log_e \frac{T_s - I}{T_s - F} = \log_e \frac{338 - 50}{338 - 200} = 0.7357$$

and by substitution (1) becomes,

$$A \times 206 = 416{,}666 \times 0.7357, \text{ or}$$
$$A = 1{,}488 \text{ sq.ft. of heating surface.}$$

Using only two boiler shells each 60 in. in diameter by 16 ft. long, each would require 744 sq.ft. of pipe surface; and using 1¼-in. pipe, each would require $744 \times 2.3 = 1{,}711$ lin.ft. of 1¼-in. pipe. Having the pipes 15 ft. long and without allowing for the fittings, the coils of each boiler shell would have to contain $1{,}711 \div 15 = 114$ lengths of 1¼-in. steam pipe 15 ft. long. To afford sufficient space for placing the necessary amount of pipe surface, the total 1,711 ft. of 1¼-in. pipe should be divided among at least four boiler shells of the size quoted.

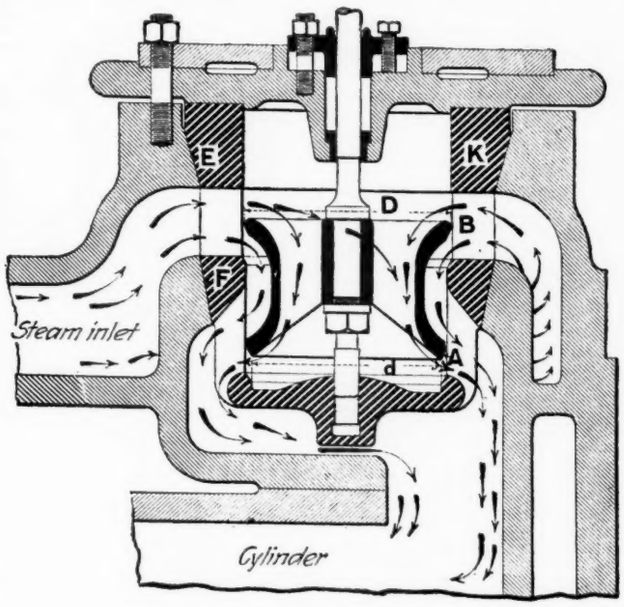
Raising the temperature of 200,000 gal., or 416,666 lb., of water through 150 deg. F. would require $416{,}666 \times 150 = 62{,}499{,}900$ B.t.u.; and as each pound (weight) of steam at 100 lb. gage pressure would part with its latent heat of evaporation = 879.8 B.t.u. per pound, the heating coils would need to be supplied with $62{,}499{,}900 \div 879.8 = 71{,}119$ lb. of steam per hour.

Double-Beat Poppet Valve

What is a single-beat or double-beat poppet valve? R. L.

The term beat, signifying a blow, is applied to a valve that is operated by a stroke parallel to the valve spindle and in closing is brought against a stop or contact piece. When the valve, in closing, is brought to rest by striking against the valve seat it is termed a poppet valve, and when there is a single contact or stopping surface it is called a single-beat valve. The simplest form of single-beat poppet valve is one in the form of an ordinary lifting check valve in which the single contact surface is the seat of the valve. This form of valve is unsuitable as a distributing valve for a steam engine, because the force required to lift the valve must be sufficient to overcome the excess of pressure acting on the back of the valve, as when there is greater pressure acting on the disk side of a globe valve. To overcome this difficulty, the valve is provided with two or more seats, each of which acts as a contact surface to receive the valve, and the parts are so arranged that, when seated, the valve is nearly balanced like a piston valve.

A sectional view of a hollow double-beat poppet valve is shown in the figure, in which the seating of the upper portion B is of larger diameter, D, than the seating of the lower portion A with diameter d, to permit of insertion of the valve in the cage EKF. The lower portion of the cage is closed and guides the valve spindle. When the valve is closed, pressure on the steam-inlet side acts on the difference of areas corresponding to the diameters D and d, and this difference may be so small that the valve, when closed, is nearly balanced.



Balanced double-beat poppet valve

Reversing Polarity of Alternator in Parallel

What would be the effect of reversing the field leads of an alternating-current generator operating in parallel with other generators? W. C.

If the polarity of the field poles is reversed in an alternator operating in parallel with other machines, the alternator will slip one pole and still operate in parallel with the other machines without any change in connections. The only exception to this rule is where two machines are driven by the same source of motive power, such as two alternators geared to the same turbine. After the machines have been properly connected to operate in parallel and for some reason the polarity of the exciting current is reversed through the field coils of one machine, the two machines would be 180 deg. out of phase and would have to remain in that relation when the machines are geared together. Where each machine is independently driven, the armatures can take any relative position to bring them into synchronism, and the direction of the exciting current in the field coils makes no difference as to parallel operation of the machines.

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

How Much Does Steam Weigh?

IN ANSWER to the question "How much does steam weigh?" the average man outside the power-plant field would probably answer, "Not much of anything!" In fact, some probably look upon it as a substance that weighs less than nothing, just as some people consider the hydrogen gas used to inflate balloons as weighing less than nothing because "it rises."

Of course steam has weight like any other form of matter. In fact, each molecule of steam weighs exactly as much as a molecule of water. The weight of a cubic foot must depend on the number of molecules present. In the liquid form, where the molecules are closely packed relatively, this weight will be large, decreasing slightly as the water expands with increasing temperature.

Water Heaviest at 39 Deg.

At the freezing point (32 deg. F.) a cubic foot of water weights 62.418 lb. As the temperature is raised this increases slightly at first, reaching a maximum of 62.425 lb. at 39.1 deg. Above this temperature the density of water continually decreases as the temperature is raised, reaching 59.83 lb. per cubic foot at 212 deg.

Above this temperature liquid water cannot exist in the open air, but if sufficient pressure is applied to keep it from evaporating, the temperature can be raised further with continued expansion. At 300 deg. the weight of a cubic foot will be 57.33 lb. and at 400 deg. 53.5 lb.

While the density of water decreases slowly with rising temperature, that of saturated steam increases rapidly. The reason is that to keep steam continually saturated as the temperature is raised, the pressure must be raised also.

Vapors are almost as compressible as gases, so that as the pressure goes up the volume must decrease rapidly. For gases there is a simple rule that the density changes in exact proportion to the pressure if the temperature stays constant. For example, a cubic foot of air at 32 deg. F. and atmospheric pressure (14.7 lb. absolute) weighs 0.0807 lb. If the air is compressed to 14.7 lb. gage the total pressure will be 29.4 lb. absolute, just double the original. If the temperature is 32 deg. F. the same as at the start, the weight per cubic foot will be 0.1614 lb., just double that at the start. In the same way tripling the absolute pressure (at constant temperature) will triple the density, and cutting the pressure in half will halve the density.

This simple rule naturally cannot be applied directly to saturated steam, because the temperature of the steam necessarily varies with the pressure. However, even if allowance is made for this temperature variation, there is no simple rule such as holds for gases. At the same time the density of saturated steam does increase *very roughly* in proportion to the pressure, as may be seen from the steam tables.

Enormous Volumes of Exhaust Steam

Take for example the low pressure of one pound per square inch absolute. This corresponds closely to that of the steam leaving a steam engine or turbine to enter a condenser carrying a 28-in. vacuum. At this pressure the temperature is only 102 deg., so that the hand could be held in the steam without discomfort. The weight of a cubic foot of steam under these conditions is only 0.00300 lb. To put it another way, a single pound of steam under these conditions will occupy 333 cu.ft.

This explains the large diameter and blade area of steam turbines at the low-pressure end as well as the large size of the exhaust connection to the condenser. A 10,000-kw. turbine using 13 lb. of steam per kilowatt-hour will take at full load 130,000 lb. steam per hour. With 28-in. vacuum this gives about forty-three million cubic feet of steam per hour, or 12,000 cu.ft. per second, passing from the last row of blades to the condenser.

With 30 sq.ft. of cross-sectional area in the exhaust connection, the velocity of the exhaust steam would be $12{,}000 \div 30 = 400$ ft. per sec., or more than 270 miles per hour.

A Rough Rule for Steam

Going back to the original figure of 0.00300 lb. per cubic feet at one pound pressure (absolute), let us see what happens when this pressure is continually doubled. At 2 lb. pressure the density is 0.00576, somewhat less than double. At 4 lb. it is 0.01107, at 8 lb. 0.02115, at 16 lb. 0.04042, at 32 lb. 0.0773, at 64 lb. 0.1482, at 128 lb. 0.2854, at 256 lb. 0.553, and at 512 lb. 1.10.

Up to this point, particularly for pressures above atmospheric, the density does very roughly double each time the pressure is doubled. A rough rule for the range from 50 to 500 lb. pressure can be obtained by noting that at 100 lb. absolute the density is about 0.22 lb. per cubic foot. Then at some other pressure, say 200 lb. absolute, the density should be about $2 \times 0.22 = 0.44$ lb. per cu.ft. The actual density at this pressure is 0.437 lb. per cubic foot.

Such a rough rule should not be used for exact computations. Within the range given it is close enough for choosing the proper pipe size to carry a given weight of saturated steam per hour at a given steam velocity.

In problems of this kind extreme accuracy is unwarranted. For one thing the selection of the proper velocity is more or less of a guess at the best. Where one engineer will figure on 6,000 ft. per minute, another will take 8,000. Even if it were easy to decide on the proper velocity, it would still be necessary to choose the nearest pipe size, which might differ in area by 10 per cent from the computed size.

As the pressure is continually increased, saturated steam gets more and more dense, while water at the same temperature becomes lighter and lighter. If this keeps on indefinitely, it is evident that a point will be reached where steam is as heavy as water. As a matter of fact this condition is actually reached at a pressure of about 3,200 lb. and a temperature around 706 deg. F. At this point one cubic foot of steam weighs 20 lb. and a cubic foot of water has the same weight. If a boiler were built sufficiently strong to withstand this enormous pressure and the pressure were steadily raised, the water line would disappear when 3,200 lb. was reached. This seems reasonable when it is considered that the water and steam would then have the same density, so that they could mix throughout the boiler.

Water Like Steam at Critical Point

Not only do water and steam have the same density at this pressure and temperature; they cannot be distinguished in any other way. Starting from opposite extremes, they become the same in every respect. They look alike and contain the same amount of heat. The point where this occurs is known as the critical point, and the pressure of 3,200 lb. and the temperature of 706 deg. are known respectively as the critical pressure and critical temperature. Until recently the critical point was only of academic interest, but with the advent of plants of extremely high pressure it has come to have more or less interest for practical engineers.

Water-Power Versus Steam-Power Costs*

By GEORGE A. ORROK
Consulting Engineer, New York City

THE design, construction and operating results of large steam plants are well known, and from examples that have already been constructed, the cost figures, which most probably would result under any given combination of circumstances, can be predicted accurately. We know, for instance, that it is possible today to construct an electric generating station, using steam as the motive fluid and coal as the fuel, in which the cost will not exceed $100 per kilowatt installed. It is known quite accurately that such a station, when supplied with reasonably good coal, will have a coal consumption around 1.1 lb. per kilowatt-hour when run under the best conditions, and the law under which the coal consumption varies with the station load factor is known. Within reason the labor and maintenance costs are known, and assuming fixed charges at 15 per cent, with coal costing from $4 to $10 per long ton at the station, suitable curves, shown in full lines Fig. 1, can be drawn which will show the cost per kilowatt-hour delivered to the distribution system at any given load factor.

For the steam station the figures have been based on five 50,000-kw. units, allowing one as reserve and using 200,000 kw. as the peak load on the station from which the load factor has been figured. A good coal has been used—Pocahontas or equal—and it has been assumed that the installation will be modern in all its details and located where there is an adequate supply of good condensing water. In general the figures given are such as any good engineering firm would be willing nowadays to guarantee to its clients.

With hydro-electric power, on the contrary, no such general statement can be made, and a separate and accurate estimate must be made for each and every condition. Some time ago, in the discussion of a problem of this kind, I developed a set of curves, Fig. 2, which covered the cost per unit of electricity generated by water and transmitted over a 300-mile line to the point of use, which, in this instance, was a large city, and these curves are sufficiently accurate for this discussion. The transmission line was figured at $50,000 a mile and the entire plant was proportioned on the basis of a demand on the peak of 200,000 kw. delivered at the point of use 300 miles away. This necessitated 250,000 kw. of installation with no reserve, a four-circuit transmission line, the necessary step-down apparatus and the high-tension underground cables and other apparatus necessary to connect up this large amount of power to the distribution system of the city.

As the cost of the installation could be known only in a general way, these figures were made to cover a wide variety of total installation costs per net kilowatt of demand, and the cost per unit was worked out for various load factors from 20 to 100 per cent, or from 1,750 to 8,760 hours of use per year. From these curves can be readily read the cost of power delivered. With these curves and those that were made for the steam station, the price of which included its connection to the distributing system, it is possible to make a rather accurate comparison of the respective advantages of steam power or water power under the conditions stated.

It will be seen in Fig. 1, that for $4 coal and 100 per cent load factor, corresponding to an output of 1,750,000,000 kw.-hr. per annum, the total cost of steam power generated in a large city and water power generated 300 miles away and transmitted to the city, are about even when the cost of the hydraulic generating station does not exceed $150 per kw. installed. This point with $6 coal is about equal to a $200 per kw. water-power installation and with $8.50 coal to $250 per kw. water-power installation. The curves of the steam station are a good deal flatter, however, than the curves for hydro-electric stations, and the various

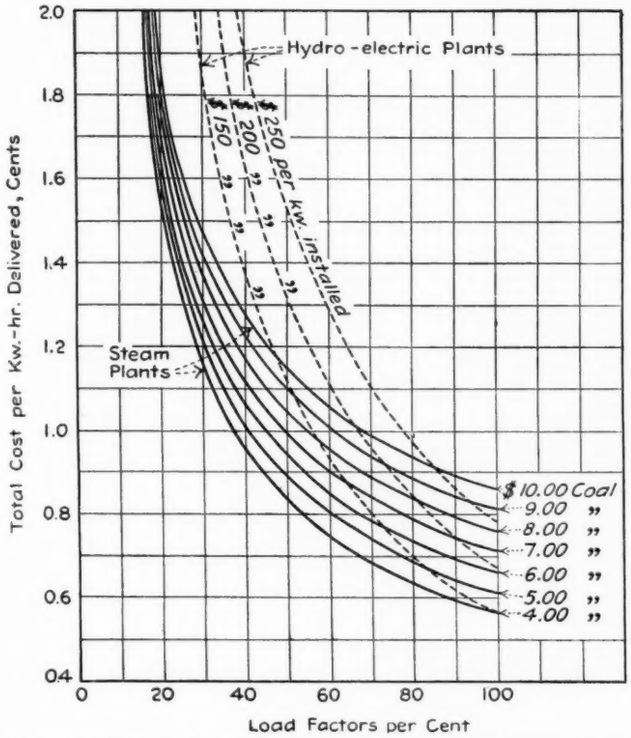


Fig. 1—Comparison of steam-power and water-power costs per kilowatt-hour delivered

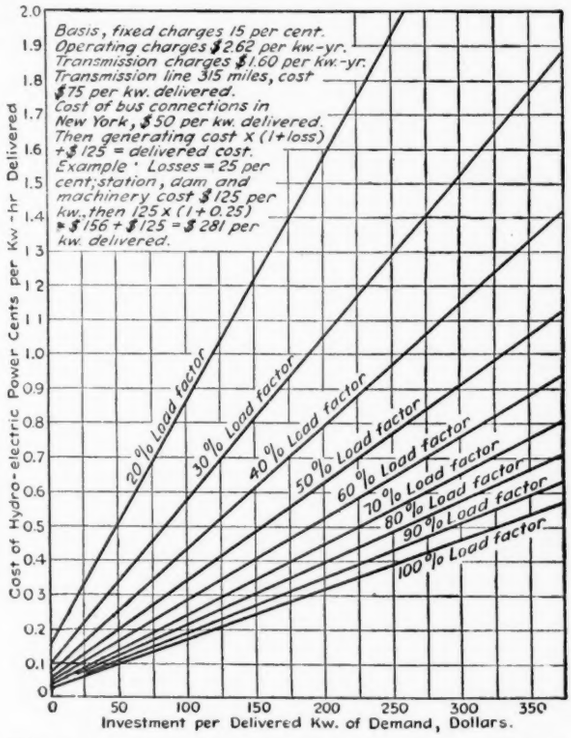

Basis, fixed charges 15 per cent.
Operating charges $2.62 per kw.-yr.
Transmission charges $1.60 per kw.-yr.
Transmission line 315 miles, cost $75 per kw. delivered.
Cost of bus connections in New York, $50 per kw. delivered.
Then generating cost x (1+loss) +$125 = delivered cost.
Example: Losses = 25 per cent; station, dam and machinery cost $125 per kw., then 125 x (1+0.25) = $156 + $125 = $281 per kw. delivered.
20 % Load factor
30 % Load factor
40 % Load factor
50 % Load factor
60 % Load factor
70 % Load factor
80 % Load factor
90 % Load factor
100 % Load factor
Cost of Hydro-electric Power Cents per Kw.-hr Delivered
Investment per Delivered Kw. of Demand, Dollars.

Fig. 2—Costs of hydro-electric power at different installation costs and load factors

*Presented as a discussion on a paper, "The Principles Underlying Hydro-Electric Development," by John R. Freeman, read at the American Society of Mechanical Engineers Convention, Dec. 3 to 6, 1923.

load factors at which the hydro-electric becomes uneconomical can be readily seen from the diagram.

Using the water-generation curves at $150 per kw. of installation, it will be noted that as the price of coal increases the load factors at which hydro-electric power becomes attractive decrease. With $5 coal this limit is 83 per cent, $6 coal about 73 per cent, $7 coal about 64 per cent, $8 coal about 58 per cent. From the curves it will be seen that about 40 per cent is the low limit for the use of hydraulic power, however high may be the coal price.

It is believed that in the calculations that have been made to construct the curves, a leaning has been indicated toward the hydro-electric rather than the steam side, and some of my friends have criticized me for using such a high figure for the cost of the steam generating stations. The value $50,000 used as the cost of a four-circuit 250,000-volt transmission line has been criticized as being too low, and probably the advantage has been given in this case to the hydro-electric installation.

Some years ago I had occasion to investigate more than three hundred water-power prospects, mostly in New York State. Considerable work was put into surveys, and the estimates showed that the installation cost of these powers averaged $450 per kilowatt. Only a very few ran under $200 and none under $150. It appeared from this investigation that coal must approach $10 to $12 a ton before even a small number of these projects would become commercial. But the larger powers of the St. Lawrence and Niagara may possibly figure in the range indicated in the curves and make up for the additional cost of long-distance transmission.

In pre-war times, when coal seldom rose above $5 per ton, $125 per kilowatt of installation was considered as the limiting sum that could be spent on a hydro-electric installation, even where short transmission lines were involved. With the increased prices for coal, as well as the cost of all construction work, this figure may, perhaps, be as high as $200 per kilowatt where the market is not far away.

Determination of the Fineness of Powdered Coal

By W. A. Selvig[1] and W. L. Parker[2]

A report of investigations by the Department of the Interior, Bureau of Mines describes in detail methods of determining the fineness of powdered coal by sieving. It appears that the total annual consumption[3] in the United States is about 12,000,000 tons and growing steadily. As the coal is usually pulverized so that 70 per cent or more passes through a 200-mesh sieve, it presents difficulties in sieving because such finely divided material tends to clog the meshes. A fineness test is desirable in order to judge the efficiency of the pulverizing apparatus and as an indication of the particle size of the coal being burned. Hand sieving is preferred as a standard method.

The requirements of the "United States Standard Sieve Series" which have been pretty generally adopted for laboratory sieves were specified for the testing sieves. The sieves used were the No. 100, 140 and 200. These correspond to the better class of testing sieves on the market, which are usually known as 100-, 150- and 200-mesh sieves. The frames are circular, being about 20 cm. (7.87 in.) in diameter, with about 5 cm. (1.97 in.) between the top of the frame and the wire cloth. The wire cloth is made from brass, bronze or other suitable wire and mounted on the frames without distortion. The joint between the cloth and the frame is smoothly filled with solder or so made that the material will not catch. The screens are not designated by mesh, but by abstract numbers, with specified size of opening, wire diameter and tolerances in average opening, wire diameter and maximum opening.

Detailed descriptions of hand and machine sieving methods are given, as well as tests and conclusions, which latter favor hand sieving in preference to machine methods. The conclusions are:

1. A method for determination of fineness of powdered coal by hand sieving on United States Standard Sieve Series Sieves Nos. 100, 140 and 200 has been standardized and tested by twelve co-operating laboratories.

2. For routine testing a method of machine sieving has been standardized and tested by nine co-operating laboratories. Owing to differences of sieving action, which may occur with different mechanical-sieving devices, it is recommended that the hand-sieving method be adopted as standard; and if machine-sieving devices are used, the results obtained should be compared to those obtained by hand sieving in order to see whether the sieving action is the same.

3. Considerable variation in sieving values may occur between sieves that conform to the specifications of the United States Standard Sieve Series—these differences between two sieves may amount to as much as 6 per cent.

4. The same operator, in duplicate tests by the hand-sieving method, using the same sieves, should check within 1 per cent in all sizes. Different operators using different sieves should check within 3 per cent on the through 200 material when the sieving value correction for the sieve used, as determined by the Bureau of Standards, is applied. Until such time as standard material is available for determining sieving value corrections for the Nos. 100 and 140 sieves, it is not possible to specify check limits, for different operators using different sieves, for the material sieved on the No. 100 and 140 sieves.

[1]Assistant chemist, Pittsburgh Experiment Station, Bureau of Mines, Department of the Interior.

[2]Junior organic chemist, Pittsburgh Experiment Station.

[3]"American Fuels," by Bacon and Hamor, first edition, vol. 1, 1922, p. 556.

Low-Temperature Distillation of Coal

Some of the processes for the distillation of coal and the conditions governing them were described by William H. Blauvelt, on Dec. 18, at the meeting of the Metropolitan Section of the A.S.M.E. The resins and cellulose or humus in coal represents the volatile matter; it is the latter which causes deterioration or spontaneous combustion due to oxidation by the air. Coke is the result of the melting and burning of the resin which occurs after the humus or cellulose is driven off. It requires high temperature distillation. The escaping gas tends to form a large cellular structure. Coke, in this lecture, refers only to good carbonaceous coke such as used in metallurgical work. Other grades in which the resin has not all been driven off are spoken of as char.

In describing the various methods of heating coal so as to drive off the humus, Mr. Blauvelt dwelt on the fact that coal and coke are poor heat conductors. Therefore, thin layers of coal or else means of agitating coal in the heaters are necessary in order to secure economical production. Flue temperatures of 1,400 to 1,000 deg. C. are usually employed with about 1,000 or 500 deg. affecting the coal.

A process successful in Europe would not necessarily be so in the United States. Commercial success depends largely on the market, and petroleum is much more salable abroad than in this country. The same is true of many other distillates. The public must be educated in order to secure a market for products such as phenol and cresol. The latter has a higher specific gravity than ordinarily used for treating lumber. While the manufacturers object to it on this point, there appears no valid objection if the proper method of using is applied.

Processes abroad consist mainly of furnaces with mechanical devices for agitating the coal. One trouble encountered was sticking of the material to the agitating members. In this country an agitation process is at present commercially operating, while it appears that desirable results may be expected from the Caracristi process. This is a genuine low-temperature process in which the volatile matter is not subjected to any higher temperature after leaving the coal, and was fully described in the May 29, 1923, issue. In the discussion that followed it was brought out that about three dollars worth of volatile matter per ton of coal was consumed in a power house, which, if abstracted, would make considerable difference in the cost of the fuel. If appeared, however, that this was not produced in a form easily recoverable. Coke of good quality, when properly suited in size to the furnace or stove, is superior to anthracite for domestic consumption. Those using anthracite should be educated as to the proper manner of utilizing coke.

News in the Field of Power

Governor Smith Offers Plan for State-Controlled Power

Proposes To Finance Power Projects Without State Bond Issues—Urges Municipal Regulation of Public Utilities

IN HIS annual message at the opening session of the New York State Legislature on Jan. 2, Governor Smith laid particular stress on development of the water powers of the state and on regulation of public utilities. Pointing out that for years the people of the state have been unable to progress beyond the barest declaration of policy, to the effect that the state should perpetually own and develop its resources, the Governor offered a concrete plan that would circumvent the chief obstacle heretofore standing in the way of state development, namely, the use of state money or credits.

The plan would provide for the establishment of a New York State Power Authority which would be a corporation without stockholders and having the authority to take over and develop the power resources of the state. It would be authorized to issue bonds exempt from state taxation and secured entirely by the revenues to be derived from the improvements when made. The bonds would not be regarded as debts or obligations of the state. The valuable franchises which the state itself would thus own, would, in the opinion of the Governor, be capitalized not in the interest of private stockholders, but in the interest of the public. Its service and rates would always be subject to the control and regulation of the state.

In the plan proposed authority would be vested in three commissioners to be appointed by the Governor for overlapping terms of reasonable length. They would be empowered to co-operate with the Canadian authorities and the federal government with reference to the development of border streams, such as the St. Lawrence and Niagara, and would also represent the state in conferences with other states or the federal government with reference to super-power plans and other interconnection projects. With regard to superpower, the Governor expressed his views as follows:

We are not in this state opposed to any superpower plan. We are ready to deal with anybody for the use of our power in return for power from other states. But before we talk superpower plans, we should develop and control our own sources of supply in our own states . . . We have heard much recently of superpower proposals, that is to say, power development which would break down state lines and state control and develop power on a regional basis. If such projects are turned over to private companies, a monopoly may be created more powerful and more sinister than any which this country has known before. It might control all industries, municipalities, and even homes and farms. It might determine who shall have power and who shall not, thus denying it to the farm and industry in outlying districts, except at a very high price, and it could at will throttle or expand the growth of communities on the basis of profit, and not on the basis of the common good.

Referring to the rejection by the people last fall of the Adirondack water-power amendment, the Governor believed this to be an unmistakable indication of the attitude of the people of the state toward development of its water powers. Once the great rights, franchises and properties of the state in water power and the rights of way are granted to a monopoly, they can be repurchased and condemned only at prohibitive prices. This has been the history of gifts of public resources and rights of way for the past century.

With a view to clearing the way for the regulation proposed, the Governor urges the repeal of the existing laws on water power as passed in 1921 and 1922.

Another feature of the message was the proposal that regulation of public utilities be taken out of the hands of the State Commission and vested in municipal bodies, except such municipalities as do not desire to or do not have machinery for such regulations, in which case the state would continue to exercise the regulatory power to be vested in the hands of a small commission of three members.

Vetoes Purchase of Boilers and Superheaters

Frank E. Doremus, Mayor of Detroit, has vetoed the recent authorization of the Common Council for the Public Lighting Commission to enter into the contract with the Babcock & Wilcox Co. for furnishing and installing eight boilers and eight superheaters for the new power plant for the sum of $399,416. The reason given for the veto was that the contract was not awarded to the lowest responsible bidder as the charter of the city provides. The mayor stated that if it was the judgment of the Commission to select a particular kind of boiler or any other particular kind of article, they must specify that particular article or those particular articles if they would not offend the charter provision that requires all bids to be awarded to the lowest responsible bidder with adequate security. It is expected that re-advertising for bids will be carried out, as suggested by the mayor for boilers, powdered-coal equipment, deaërators, evaporators, feed pumps, heaters, cranes, condensers and sub-structures including the intake and discharge for cooling water. Other items will then follow as soon as necessary for the proper procedure of the work.

Power Generation Expansion in California

Extensions in hydro-electric and steam power plants in California during the last year have developed the total generating capacity of utility companies operating in the state to a gross of 1,000,000 hp., according to estimates made by the Gas and Electrical Division of the State Railroad Commission. The principal expansion in 1923 included the completion of a power plant on the Pit River by the Pacific Gas & Electric Co., with rated output of 80,000 hp.; the installation of an additional 20,000-hp. unit by the San Joaquin Light & Power Corp. at its natural-gas-burning steam plant in the Midway oilfields; and the construction of a 15,000-hp. addition to the Capco hydro-electric generating plant of the California-Oregon Power Co. During this year the Pacific Gas & Electric Co. placed in service successfully its transmission line from the Pit River project, 250 miles to the nearest available market.

In connection with proposed 1924 development it is pointed out by the Commission that the Great Western Power Co. is preparing for the installation early in the year of a new 30,000-hp. unit at its Caribou plant; the San Joaquin Light & Power Corp. is beginning work on a hydro-electric development on the Kings River; the Pacific Gas & Electric Co. will proceed with its Pit River development for the No. 3 power plant, to have a capacity of 100,000 hp.; the Southern California Edison Co. will carry out work at its Big Creek development for an additional plant capacity of 125,000 hp., as well as construct a steam-operated station at Long Beach; and the Western States Gas & Electric Co., will engage actively for additional capacity at its American River hydro-electric development.

Canada Has Extensive Plans for Hydro-Electric Power

The total water-power installations in Canada are now about 3,250,000 hp., with another 750,000 hp. under way. Some 250,000 hp. will be installed during 1924, and it is quite probable that within two years the total installations will be 4,000,000 hp. This does not make any allowance for the possible development along the upper St. Lawrence River.

Barge Power Plant for Municipal Service

To provide for increasing demands for electric service in the harbor section for dredging and other municipal work, the City of Longview, Wash., has work under way on an auxiliary power station, to be mounted on a barge stationed in the harbor. The plant will consist of a 1,500-kw. turbo-generator, with oil-burning boilers; the entire equipment, with condenser and auxiliary apparatus will weigh approximately 55 tons. The new floating power plant will supplement the service of the North Coast Power Co. in this vicinity.

Three Generators Ordered for Pit No. 3

For the power house at Pit No. 3, located on the Pit River, California, the Pacific Gas and Electric Co. has recently placed orders with the General Electric Company for three generators. These generators will be of the vertical type with a thrust bearing at the top for supporting the entire rotating element and will have a rated capacity of 27,000 kva. each. They will generate at 11,000 volts, three phase, 60 cycle, and will be furnished with direct-connected 250-volt exciters. One combined motor- and waterwheel-driven spare exciter will be used.

Southern California Edison 70,000-Kw. Steam Plant

As announced briefly in the Dec. 25, 1923, issue of *Power*, the Southern California Edison Co. is to build a steam plant of 70,000 kw. capacity at Long Beach, Calif., about twenty miles west of Los Angeles. Additional details can now be given: The plant will contain two 35,000-kw. horizontal turbo-generators, and steam will be supplied by eight 1,600-hp. boilers with superheaters, economizers and combination oil- and gas-burning furnaces. The boilers will be built for 400 lb. steam pressure and the turbines will operate at 350 lb. pressure with a superheat of about 260 F. The steam rate for the new turbines will be approximately 10 lb. per kw.-hr.

The design and all the equipment for the plant will be of the most modern type, and it is expected that the station will make a new record for efficiency in oil-burning plants. It is expected that delivery on the equipment will be made in sufficient time to permit the plant to be placed in operation early in 1925. In order to distribute the power from this plant, it is proposed to construct six new 60,000-volt circuits on a new steel tower line adjacent to the present transmission line from the old steam station. The growth of the company's load has been so rapid that it has been estimated that it will be necessary to cut in a new substation on an average of every five days during 1924.

An order totaling approximately $1,000,000, which includes the two 35,000-kw. turbines, has been placed with the General Electric Co., Los Angeles. The new steam plan will involve an expenditure of $3,000,000 exclusive of the new transmission lines to be built.

The development program of the Southern California Edison Co. for 1924, recently announced, contemplates the expenditure of $26,288,000 for new work. Following are the major items included in the budget: Florence Lake Tunnel, $5,879,000; new units in Big Creek power houses No. 1 and No. 2 to be placed in operation in 1925; 25,000 kva. unit in P.H. 1 and 16,000 kva. unit in P.H. 2, $2,100,000; dam and tunnel work, $1,700,000; 70,000-kw. steam plant, and additions, $3,000,000; distribution lines, $5,943,000; distribution substations, $2,394,000; transmission lines and stations, $1,106,510.

Herbert Hoover's Forecast For 1924

THE economic outlook for our own country for the next year is bright. In general the world situation is hopeful. The general spirit of prudence, the absence of speculation, complete employment, high production, and the great financial strength and stability of the important states in the Western Hemisphere, together with the promise of the early conference for systematic consideration of constructive solution of the world's greatest economic menace — Franco-German relations—all create a hopeful foundation on which the New Year may build.

In 1923 the United States witnessed the highest total productivity and movement of commodities since the war, with full employment, high real wages, greatly increased savings, large additions to home building, and the largest increase in railway equipment since the war.

The basis of healthy business activity lies in balanced budgets, stable currency, high production accompanied by proportionate consumption and savings with an absence of speculation, extravagance and inflation. These things we have in the United States. We have even more in the hope of decreasing taxes. The odds are favorable to 1924.

F. C. Wight Becomes Editor of Engineering News-Record

Frank C. Wight, associated with the *Engineering News* and *Engineering News-Record* for 17 years, has recently become editor of that publication. Mr. Wight succeeds, as editor, E. J. Mehren, who has become vice-president of the McGraw-Hill Co., Inc., in charge of the publishing management of four of the McGraw-Hill magazines, including *Engineering News-Record.*

British Empire Exhibition To Show Power Station

The electrical and allied engineering section of the exhibition, which occupies a floor space of about 3½ acres in the Palace of Engineering, has been organized by the British Electrical and Allied Manufacturers' Association.

On the north side of the section there will be a completely equipped boiler house, power station of 6,000 hp., together with a substation. In the boiler house every appliance available for saving labor will be shown. Among the larger applications of electric power, those of special interest to the public will be the electric appliances for driving trains and tramways and those for use in factories, according to the *Christian Science Monitor.*

Girand Starts Work on Diamond Creek

Advices have reached Washington through official channels that James B. Girand has begun work on his project at Diamond Creek on the Colorado River. The work was begun Dec. 18, 1923, by Mr. Girand prior to the expiration of his state license, Dec. 26.

Since the Federal Power Commission has not extended the requisite authority to proceed, it is anticipated that an injunction will be sought immediately in the federal courts. It is believed that Mr. Girand fully expects this action to be taken, and his action in starting work is thought to be a strategical step to preserve his rights under the state license. Notice had been given by Governor Hunt of Arizona that the state license would not be extended. By beginning construction work prior to its expiration, it is believed that he has complied with the conditions of the state license since the work will be stopped by the federal government, a circumstance beyond Mr. Girand's control. It is stated that Mr. Girand has eighteen men at work clearing the ground at the Diamond Creek site.

It will be recalled that an application of the Colorado Engineering & Development Co. to the Federal Power Commission was denied pending an agreement between the seven Colorado River Basin states. The project is at the mouth of Diamond Canyon, north of Peach Springs, Ariz., and is to include a dam 300 ft. high and 1,200 ft. long to develop 200,000 hp.

Pinchot's Draft of Coal Act Is Being Considered by Governors

Proposed Legislation To Regulate the Anthracite Coal Industry Has Been Approved by Various Governors

THE proposed legislation which is designed to regulate the anthracite industry, drafted by Governor Pinchot of Pennsylvania, has been transmitted to the governors of the anthracite consuming states for their criticisms and suggestions. Governor Pinchot hopes to have the proposed legislation introduced in Congress early in January.

In the letter accompanying the draft, the Governor asks for effective interest and co-operation of the other Governors in his proposed legislation. He reiterates his statement that the proposed compact of states offers a practical way to reduce prices to the consumers, that there can be no dispute as to its legality, and that it offers, as no other method can, a uniform and unbroken system of control along the line from the mouth of mine to the consumer's bin. "It applies a more powerful means to curb the exactions of monopoly than has ever been used in America."

It is entitled "An Act to Regulate Interstate and Foreign Commerce in Anthracite Coal and for Other Purposes," and is divided into nine articles. Article I—is devoted to definitions. Article II—tells of the "Public Interest in Coal." Article III—"Unlawful Practices Defined," states that "It shall be unlawful for any person engaged in the production, distribution or sale of anthracite coal to (a) engage in or use any unfair, unjustly discriminatory or deceptive practice or device in commerce; (b) charge or receive any unreasonable margins or prices in commerce; (c) make or give, in commerce, any undue or unreasonable preferences or advantage to any particular person or locality in any respect whatsoever, or subject, in commerce, any particular person or locality to any undue or unreasonable prejudice or disadvantage in any respect whatsoever; (d) sell or otherwise transfer to or for any other person, or buy or otherwise receive from or for any other, aarticle for the purpose or with the effect of manipulating or controlling prices in commerce, or of concealing profits or of creating a monopoly in the acquisition of, buying, selling, dealing in, any article in commerce, or of restraining commerce; (e) engage in any course of business or do any act for the purpose or with the effect of manipulating or controlling prices in commerce, or of creating a monopoly in the acquisition of, buying, selling or dealing in, any article in commerce, or of restraining commerce; (f) engage in any practice, make any regulation or charge or receive any margin or price, not in commerce, which causes any undue or unreasonable advantage, prejudice or preference as between persons or localities in intrastate commerce on the one hand and commerce on the other hand, or any undue, unjust or unreasonable discrimination against commerce; (g) engage in any practice, make any regulation or charge or receive any margin or price, not in commerce, likely to obstruct, restrain or burden commerce; (h) engage in or carry on any commerce for which a license shall be required by the Coal Division under the provisions of this act before securing such license or after such license shall be suspended or revoked; (i) disobey any lawful order of the Coal Division; (j) conspire, combine, agree or arrange with any other person to do or aid or abet the doing of, any act made unlawful by subdivision (a), (b), (c), (d), (e), (f), (g), (h), or (i). Article IV treats of the "Creation and Organization of the Coal Division of Interstate Commerce Division." This Coal Division is to be composed of three commissioners with a salary of $10,000 a year who are to be appointed by the President, by and with the advice and consent of the Senate. Not more than two of the commissioners shall be of the same political party. Term of office to be five, six and seven years respectively from the date of the taking effect of this act.

Article V—"Powers and Duties of Coal Division" are fully outlined and include among others: The investigation of ownership and titles of mines; the persons connected with the anthracite coal industry directly and indirectly; rents and royalties; methods, costs, profits, and general conditions of production; wages and wage contracts, hours of labor, the regularity of employment, housing conditions and living standards of the mine workers and the general conditions of labor, methods, costs, profits and general conditions of distribution; causes which from time to time induce strikes and lockouts, waste of anthracite coal, all other facts, circumstances and conditions of the anthracite industry. It gives power to the Coal Division to demand of persons engaged in the anthracite industry the filing of such reports or answers as it may require and to prescribe the form of any and all accounts, records and memoranda to be kept by persons engaged in commerce in anthracite coal, to inspect any and all coal belonging to persons engaged in commerce in anthracite coal, to require by subpœna the attendance and testimony of witnesses, etc., and provides penalties or forfeitures.

Article VI defines "Powers and Duties of Coal Division in National Emergency." Article VII covers the "Issuance and Enforcement of Orders of the Coal Division," and Article VIII prescribes the penalties that can be imposed. Article IX takes up the general provisions.

Engineers Urge Technical Board for St. Lawrence

The American Society of Civil Engineers is urging the enactment of legislation providing for the appointment by Congress of a special Technical Board to investigate and report upon improvements of the St. Lawrence River as recommended by the International Joint Commission. The Board of Directors of this Society believes that such a Technical Board should be appointed and that it should be so constituted that all phases of this problem may be considered. The matter will be taken by them to the Committee of the Senate and the House to which this matter has been referred, with the recommendation that a commission confined to this country or a joint commission of both Canada and the United States be appointed to give further study to the essential facts involved in the St. Lawrence waterway project, so that Congress may be properly guided in the consideration of this problem, so important to a large section of the United States.

It is expected that other engineering societies, both Canadian and American, that are interested in the St. Lawrence development will take action similar to that taken by the A.S.C.E.

Chicago A.S.M.E. Power Meeting Plans

Plans for the Power Meeting to be held on Jan. 15 by the Chicago Section of the American Society of Mechanical Engineers are progressing, and the entire day is to be devoted to it. At the morning session, starting at 10 a.m., there will be two papers—one on "The Central-Station Power Plant," by C. F. Hirshfeld, of the Detroit Edison Co., and the other on "Power Generation in the Modern Steel Plant," by G. R. McDermott, assistant chief engineer of the Illinois Steel Co.

In the afternoon five papers have been assigned, as follows: "Underfeed Stokers and Their Use with Middle West Coal," by Joe Worker, of the American Engineering Co.; "Burning of Waste-Coal in Pulverized Form Under Boilers," by Ralph Galt, Fuller Engineering Co.; "Pulverized Coal," by Henry Kreisinger, Combustion Engineering Corp.; "Heat Absorption," by Lloyd R. Stowe, Laclede-Christy Clay Products Co.; "Forced-Draft Chain-Grate Stokers," by J. Van Brunt, Combustion Engineering Corp.

The evening is to be given over to a dinner meeting at the Hamilton Club, at which Fred. R. Low, the new president of the Society, and C. F. Kettering, president of the General Motors Research Corporation, Dayton, Ohio, will be the principal speakers.

The meetings throughout the day will be held in the rooms of the Western Society of Engineers. With a program of the proportions indicated, a large attendance is anticipated. With the

variety of subjects during the day there should be interest for all, and in the evening it is particularly desirable that as many as possible be in attendance to welcome the chief official of the Society and hear what he may have to say of his plans for the year.

Society Affairs

The Hartford Section of the A.S.M.E., on Jan. 14, will hear A. H. Rund speak on "Safety to Life and Limb, from an Engineering Standpoint."

The Minneapolis Section of the A.S.M.E. will have a dinner meeting on Jan. 28, at which Prof. C. F. Shoop, of the University of Minnesota, will give an address on the "Mercury Vapor Boilers."

The Philadelphia Section of the A.S.M.E. will hear F. W. Speer, of Pittsburgh, speak on the "Coal Carbonization Having Particular Relation to the Problem of the Power Engineer," at its Jan. 22 meeting.

The Cincinnati Section of the A.S.M.E. will hear Prof. C. A. Joerger, of the University of Cincinnati, speak on "Coal Conservation," at its Jan. 24 meeting, which is to be held at the Literary Club rooms.

The Cleveland Section of the A.I.E.E. will hear about "Remote Control of Power by the Use of Automatic Apparatus," at its Jan. 24 meeting. Mr. Wensley, of the Westinghouse Electric & Manufacturing Co., will be the speaker.

The Virginia Section of the A.S.M.E. will consider at its Jan. 18-19 meeting at Norfolk, Va., "Industrial Preparedness." George S. Pope will speak on "Community Coal Storage"; H. L. Straube on "Coal-Handling Facilities"; William D. Mount on "Waste in Industry."

The Birmingham Section of the A.S.M.E. has as the general topic of its Jan. 16 meeting, "Team Work." L. Sevier will speak on "The Relation of the Engineer to the Manufacturer"; Frank Rushton will tell of "The Relation of the Engineer to the Community"; Judge W. E. Fort will have as his subject, "The Relation of the Engineer to the Public at Large."

The Metropolitan Section of the A.S.M.E. will hold a joint meeting with the A.I.E.E. and the A.S.C.E. on Jan. 9 at the Engineering Societies Bldg., 29 West 39th St, New York City. The subject of the meeting is, "Electrical Systems of New York and New Jersey." Philip Torchio, of the New York Edison Co., will speak on "Electrical Systems of Greater New York," and R. M. Conwell, of the Public Service Electric Co., on "Transmission System of New Jersey." At the Jan. 15 meeting A. R. Mumford will speak on "Burning of Anthracite Coal."

The Toledo Section of the A.S.M.E. will have a dinner meeting at the Chamber of Commerce on Jan. 10. Albert A. Northrop, of Stone & Webster, Inc., will speak on "The Construction of the Caribou Hydro-Electric Development in California," with motion pictures showing the project.

Coming Conventions

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D. C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at the Bellevue-Stratford Hotel, Philadelphia, Feb. 4-8. Spring convention at Birmingham, Ala., April 7-10.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 18-21.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York. City. Annual meeting at New York City, Jan. 16-18.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 19-22.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

Engineers' Club of New York. Joseph Struthers, 32 West 40th St., New York City. Annual meeting on Jan. 22.

Franklin Institute. R. B. Owens, 15 South Seventh St., Philadelphia, Pa. Annual meeting Jan. 16, 1924.

Indiana Engineering Society. Charles Brossman, 1503 Merchants Bank Bldg., Indianapolis, Ind. Annual meeting at Lincoln Hotel, Indianapolis, Ind. Feb. 14-15.

Iowa Engineering Society. Blanche Veig, Acting Secretary, 406 Flynn Bldg., Des Moines, Iowa. Annual meeting at Cedar Rapids, Jan. 29-Feb. 1, 1924.

Master Boiler Makers Association. H. D. Vought, 26 Courtland St., New York City. Meeting at Chicago, May 20-23, 1924.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-14, 1924.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

Obituary

Walter H. Sawyer, a consulting engineer of distinction in the field of waterpower conservation, died on Dec. 21 at Lewiston, Me., after a protracted illness. He was born at Middletown, Conn., in 1867, and was agent and hydraulic engineer for the Union Water Power Co., Lewiston, and of the Androscoggin Reservoir Co. at the time of his death, beside being a partner in the firm of Sawyer & Bean, consulting engineers, of Lewiston. Mr. Sawyer was a foremost authority on river-flowage problems and was frequently called as an expert in hydro-electric development undertakings.

Personal Mention

George T. Bishop, chairman of the board of the Niagara, Lockport & Ontario Power Co., has recently been elected a member and chairman of the board of the United Gas and Electric Corp.

Franklin T. Griffith, president of the Portland (Ore.) Railway, Light & Power Co., has been elected first vice-president of the National Electric Light Association to succeed the late John A. Britton.

Charles W. Tubby for many years district manager for the Worthington Pump and Machinery Corp. at the St. Paul and Seattle offices, is leaving the services of that corporation and after Feb. 1 will be active in similar work in Seattle.

Business Notes

The A. D. Granger Co., 15 Park Row, New York City, manufacturer of power-plant machinery, announces that Anthony Fleck has joined its company as sales engineer.

The Sanford Riley Stoker Co., Worcester, Mass., announces that it no longer has any interest, financial or otherwise in the Ground Coal Engineering Corp. or its successor, Universal Engineers, Inc.

The American Steam Pump Co., of Battle Creek, Mich., has purchased the plant, assets and entire business of the Advance Pump & Compressor Co., of Battle Creek, which is dissolved, and announces that all business in the future will be carried on by the American Steam Pump Co.

The General Electric Co. has created a southwestern district to handle its apparatus business in Texas, Oklahoma, southern New Mexico and southeastern Arizona. The Southwest General Electric Co. will continue to act as distributing jobber in the southwestern district. C. W. Hobson has been appointed southwestern manager in general charge of this territory and L. T. Blaisdell as district manager.

The United Machine & Manufacturing Co., Canton, Ohio, announces that Joseph R. Darnell, formerly associated with the Fuels Division of the Bureau of Mines has been appointed assistant chief engineer of the company.

The United Machine & Manufacturing Co., Canton, Ohio, announces that the Riley Engineering Co. of Canada, Ltd., a division of the Underfeed Stoker Co. of Canada, Ltd., Toronto, has been granted an exclusive license for the sale and manufacture of the Harrington Forced Blast Traveling-Grate Stoker throughout the Dominion of Canada.

The Climax Engineering Co., Clinton, Iowa, recent purchaser of the factory and business of the Clinton Refrigerating Co., of that place, has also purchased the interests of the E. H. Duffey Co., of Los Angeles, formerly local distributor of the Clinton Self-Contained Automatic Control Refrigerating Machine. The local agency will continue to be operated under the name of the Climax Engineering Co., but as a factory branch rather than as an independent distribution agency as formerly.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 24, 1923	Dec. 31 1923
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.00	2.00
Clearfield	Boston	2.25	2.25
Somerset	Boston	2.50	2.50
Kanawha	Columbus	1.75	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	3.50	2.75
West Ky.	Louisville	1.90	1.93
S. E. Ky.	Louisville	1.75	2.00
Big Seam	Birmingham	2.15	2.15

FUEL OIL

New York—Jan. 3, light oil, tank-car lots, 28@34 deg. Baumé, 4¼c. per gal., 36@40 deg. 4½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Dec. 18, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70; 28@30 deg., $1.15; 32@36 deg., gas oil, $1.85 per bbl.; 36@40 deg., distillate, $1.95@$2 per bbl.

Pittsburgh—Dec. 27, f.o.b. local refinery, 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c.; 34 deg., neutral 8c. per gal.

Dallas—Dec. 29, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Cincinnati—Dec. 31, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 4¾c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6c. per gal.

Philadelphia—Dec. 29, 28@30 deg., $1.78½@$1.82 7/10 per bbl.; 18@22 deg., $1.68@$1.71 8/10; 13@16 deg., $1.57½@$1.60 7/10 per bbl.

Boston—Dec. 26, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¾c. per gal.; light oil, 28@32 deg. Baumé, 6½c. per gal.

New Plant Construction

Ark., Little Rock—The Arkansas Granite Co., recently organized, has inquiries out for air compressors and other power equipment for installation at its proposed granite quarry plant in this section. W. P. Barr is president and general manager.

Ark., Little Rock—The Monarch Mill & Lumber Co., 2501 West Seventh Stree', is planning for the construction of a steam power house, to replace the structure at its plant recently destroyed by fire. Two boilers, pumps and auxiliary equipment will be installed.

Calif., Long Beach—The Bay Hills Pipe Line & Storage Co., has plans for the construction of an oil storage and distributing plant on site selected in the harbor district, estimated to cost $1,350,000. The installation will include one 72,000-bbl. booster pump, two 80,000-bbl. storage pumps; two 40,000-bbl. storage pumps, and auxiliary power and pumping equipment.

Calif., Los Angeles — Blake, Moffitt & Towne, 242 South Los Angeles Street, paper products, will install a compressed air plant, sump pump and other power equipment at their proposed four-story and basement building, 187 x 216 ft., in rear of present works. J. D. Galloway, First National Bank Building, San Francisco, Calif., is engineer.

Calif., Orange—The City Council is arranging a special election in Jan., to vote bonds for $40,000, for waterworks improvements, to include the purchase of one 125 hp. natural gas engine and auxiliary equipment, and two 1000 g.p.m. pumps.

Calif., Pasadena — The Common Council is perfecting plans for a bond issue of $250,000, for extensions and betterments in the municipal electric power plant and system, including the installation of considerable additional equipment.

Calif., San Bernardino — The Mojave River Irrigation District plans for the installation of a number of pumping stations and power houses at its proposed irrigation project in the Apple Valley section, for which a bond issue of $2,150,000, has been approved.

Calif., San Diego—The California Clay Products Co., plans for the construction of a power house at its plant at Cardiff-by-the-Sea, for which a fund of $200,000 is being arranged for buildings and equipment. The company is associated with the Vitrified Products Corp., Victor Kremer, president, San Diego.

Calif., San Diego—The Coronado Water Co., plans for the installation of electric pumping machinery on the Tijuana River for additional water supply of 5,000,000 gals. per day. The Tijuana Irrigation District is also planning for a similar installation on the same stream for an output of 8,000,000 gals. per day. Applications have been made to the state for permission.

Calif., Santa Rosa—The City Council will install electric pumping machinery in connection with its proposed sewerage disposal plant, estimated to cost $150,000. A special election to vote bonds will be held in Feb. Clyde F. Smith, Berkeley, Calif., is consulting engineer.

D. C., Washington—The Bureau of Supplies and Accounts, Navy Department, will receive bids until Jan. 22, for rotary converters and spare parts for eastern and western navy yards, Schedule 1733.

D. C., Washington—The Supply Officer, Unitetd States Navy Yard, will take bids immediately for 23 pressure gages, req. 454.

Fla., East Tampa—The Alexander Lumber Co., Tampa, is reported to be planning for the construction of a power house at its proposed mill on property recently acquired in the Lesley section, East Tampa. T. F. Alexander is president.

Fla., Orlando — The City Council will have plans prepared for extensions and improvements in the city lighting plant and waterworks, for which bonds for $525,000 have been approved.

Fla., Sanford — The city has called a special election on Jan. 11, to approve a bond issue of $310,000 for the installation of a municipal electric power plant. Bonds are also being arranged for $160,000, for the construction of a municipal gas works Plans will be prepared in the near future.

Ga., Augusta — The City Council has tentative plans under advisement for the erection of a steam-operated electric power plant for municipal service.

Ida., Caldwell—The Idaho Canning Co., Payette, plans for the construction of a power house at its proposed local branch canning plant, for which a site has been secured.

Ida., Weiser—The Southern Idaho Land & Power Co., will have plans prepared for the construction of a hydro-electric power plant on Crane Creek, Washington County, for which permission has been secured from the Federal Power Commission. It will be equipped for an initial capacity of 25,000 hp.

Ill., Bensonville — The Village Council plans for the installation of electric pumping machinery and auxiliary power equipment at its proposed sewerage disposal plant. Bonds have been arranged for $200,000 for the project, including system. Edwin Hancock, 2047 Ogden Avenue, Chicago, Ill., is engineer.

Ill., La Salle — The Carus Chemical Works, 1375 Eighth Street, contemplates the construction of a power house at its proposed local zinc oxide plant, for which plans will be prepared in the near future. Edward Carus is president.

Ind., Indianapolis—The Sinclair Motors, Inc., Herbert Scheel, Tenth Street and Capitol Avenue, representative, plans for the construction of a power house at its proposed local automobile manufacturing plant, estimated to cost in excess of $200,000. A site is being selected.

Iowa, Cedar Rapids—The Eastern Iowa Power Co., a subsidiary of the Iowa Railway & Light Co., will install a hydroelectric power plant with initial capacity of 1900 hp., at the recently completed Pinhook Dam, Jackson County.

Kan., Wichita—The Southwestern Serum Co., 308 East Twenty-first Street, will install an ice and cold storage plant in its proposed local two-story works on East Twenty-first Street, for which foundations will be laid at an early date.

Ky., Louisville—The W. J. Hughes Co. plans for the construction of a power house in connection with the proposed rebuilding of its lumber mill and plant, destroyed by fire, Dec. 27, with loss approximating $350,000.

La., Loreauville—The Loreauville Sugar Co., plans for the construction of a power house in connection with the rebuilding of its local refining plant, known as the Vida refinery, recently destroyed by fire.

Md., Texas—The Martex Products Corp., 100 Equitable Building, Baltimore, recently organized, plans for the installation of air compressors, motors and other power equipment at its proposed marble plant in this vicinity. Raymond L. Lovell is president.

Mass., Boston — The Ford Motor Co., Highland Park, Detroit, Mich., plans for the construction of a power house at its proposed assembling plant in the Charlestown section, estimated to cost $750,000. Negotiations for a site are being consummated.

Mich., Columbiaville—The Columbiaville Woolen Mills are reported to be planning for the construction of a power house in connection with the proposed rebuilding of their plant, partially destroyed by fire, Dec. 14, with loss estimated at $110,000.

Minn., Brainerd — The Northern Pacific Railroad Co., Fifth and Jackson Streets, St. Paul, Minn., has tentative plans for the construction of a power house at its proposed local shops, estimated to cost $750,000, with machinery. J. P. Anderson is superintendent.

Minn., Moorhead—The Common Council is considering preliminary plans for extensions and improvements in the municipal power plant and waterworks, including the installation of additional equipment, estimated to cost $125,000. R. G. Price is city clerk.

Minn., Owatonna—The Common Council is arranging an appropriation of $350,000, for the construction of a municipal electric power plant, for which plans are now being drawn. It is expected to call for bids early in the spring. Jacobson & Jacobson, Auditorium Building, Minneapolis, are architects; A. L. Mullergren, Gates Building, Kansas City, Mo., is engineer.

Minn., Rochester—The Common Council plans for the installation of an electric pumping plant in connection with a proposed sewerage disposal plant. A. F. Wright is city clerk.

Miss., Scooba—R. E. Lynch has tentative plans for the rebuilding of his power plant, used for local service, destroyed by fire, Dec. 20. Additional equipment will be installed.

Mo., Ash Grove—Frank Kerr and associates are closing negotiations for the purchase of the local light and power plant, and plan to organize a company to operate the station. Extensions are proposed, including the installation of additional equipment. Tentative plans are also under advisement for the installation of an ice-manufacturing plant.

Mo., St. Louis — The Board of Public Service, City Hall, has tentative plans in preparation for initial construction in connection with proposed extensions to the municipal waterworks, for which bonds totaling $12,000,000 were recently voted. A power house will be constructed for pumping service, with triple expansion engine units now under consideration. The first pumping machinery installation will provide for a capacity of 100 m.g.d. capacity, to be later extended. Howard E. Wall is water commissioner in charge.

Mo., Seneca—The Common Council plans for the installation of a pumping plant in connection with a proposed waterworks plant and system, for which H. G. Olmstead & Co., 2230 West Eighteenth Street, Oklahoma City, Okla., engineers, have been selected to prepare plans.

Mont., Missoula—The city Council plans for the installation of electric pumping machinery and auxiliary equipment in connection with extensions and improvements in the municipal waterworks, to cost about $900,000. A bond issue of this amount is being arranged.

Neb., North York—The York Brick & Tile Co., plans for the construction of a steam power house in connection with the proposed rebuilding of the portion of its plant recently detroyed by fire.

Neb., Omaha—The Kimball Laundry Co., 1507 Jackson Street, H. A. Jacoberger, president, plans for the installation of steam and electric power equipment, conveying machinery and other mechanical apparatus in its three-story and basement plant to be located at Fifteenth and Jones Streets, estimated to cost $150,000. John Latenser & Sons, 732 Peters Trust Building, are architects.

Neb., Republican City — The Common Council plans for the installation of a pumping plant in connection with a proposed municipal waterworks, for which bids will soon be called. The city clerk is in charge.

N. J., Elizabeth—The Municipal Water Committee has tendered a report to the City Council recommending the construction of a dam at Stony Brook, near Watchung, about 12 miles distant, with reservoir, pumping plant, pipe lines, etc., for a city waterworks, estimated to cost $8,770,000. The report follows 10 months investigation. The council will take action at an early date.

N. J., Maple Shade—The Township Committee has purchased a tract of property for the construction of its proposed pumping plant for the Chester Township Water Department, for which plans will be arranged at an early date.

N. J., Pleasantville—The Peerless Plush Mfg. Co., 71 Franklin Street, Paterson, N. J., plans for the construction of a power house at its proposed local mill, estimated to cost $250,000.

N. Y., Brooklyn—The National Cold Storage Co., 66 Furman Street, has tentative plans under advisement for the rebuilding of the portion of its six-story plant on the waterfront, destroyed by fire, Dec. 18, with loss estimated at $100,000, including equipment.

N. Y., Horseheads — The Consolidated Brick Co., plans for the construction of a power house in connection with the rebuilding of the portion of its local plant, destroyed by fire, Dec. 28, with loss estimated at $200,000, including equipment.

N. C., Elizabeth City—The Ideal Hosiery Co., plans for the construction of a power house in connection with the proposed rebuilding of its local mill, recently destroyed by fire with loss estimated at $100,000.

N. C., Mebane—The White Furniture Co., is perfecting plans for the rebuilding of its power house and plant, destroyed by fire Dec. 21, with loss estimated at $300,000, including equipment.

N. C., Wilmington — The American Molasses Co., has plans for the construction of a storage and distributing plant, estimated to cost in excess of $100,000, and will install pumping equipment, steel tanks and auxiliary apparatus.

N. D., Grand Forks — The Minnesota Sugar Co., Chaska, Minn., plans for the construction of a power plant at its proposed local refinery, estimated to cost in excess of $750,000.

Ohio, Massillon—The Massillon-Greenville Gravel Co., Greenville, Ohio, is planning for the installation of electric and steam power equipment in connection with extensions in its local plant to double the present capacity. Loading and conveying equipment will also be installed. J. F. Coppock is assistant general manager.

Ohio, Toledo—The Holland Bread Co., Cannon Avenue, will install ovens, power plant equipment, conveying machinery and other mechanical apparatus at its proposed three-story and basement baking plant, 90 x 265 ft., to be located at Elm and Summit Streets, estimated to cost $185,000. Mills, Rhines, Bellman & Nordhoff, Ohio Building, are architects.

Okla., Chickasha—The City Council plans for the installation of electric pumping machinery at its proposed sewerage disposal plant and waterworks extensions, for which bonds for $70,000 are being arranged. J. C. Milliken is engineer.

Okla., Wewoka—The Central Oklahoma Light & Power Co., has acquired the local municipal power plant. Plans are under way for the installation of a substation and equipment for central station service.

Ore., Baker — The Baker White Pine Lumber Co., plans for the construction of a pumping plant at Mountain Spring for water supply for plant service, as well as a feed water system for locomtive use.

Ore., Marshfield—The Mountain States Power Co., operating the local power plant of the Coos Bay Lumber Co., has tentative plans for the installation of additional equipment, including steam turbine and auxiliary apparatus. A proposition is also being considered for the construction of a new plant in this section.

Ore., Metolius — The Columbia Valley Power Co., has plans nearing completion for the construction of a dam and hydro-electric power plant at the junction of the Deschutes and Crooked Rivers, with initial capacity of about 150,000 hp. F. R. Schanck is consulting engineer.

Ore., Newport—The Siletz Bay Lumber Co., plans for the installation of a pumping plant on a branch of the Siletz River, with pipe line 1,000 ft. long for mill and domestic water service.

Ore., Portland—The Terminal Ice & Cold Storage Co., Third and Hoyt Streets, will soon commence the construction of a new three-story plant, 100 x 100 ft., estimated to cost $75,000, to be located at Fourth and Hoyt Streets.

Ore., Union Junction—The Blue Mountain Lumber Co., has tentative plans for the construction of a new mill and power house on 40,000-acre tract of timber property.

Pa., Hazleton—The Beaver Valley Coal Co. will install electric and steam power equipment in connection with the rebuilding of its coal breaker in the Mount Grove Valley, recently destroyed by fire with loss of about $55,000.

Pa., Millvale—The Edward Vero Co., is planning for the rebuilding of the portion of its steam power house recently destroyed by fire. An official estimate of loss has not been announced.

Pa., Reading—The Keystone Slag Co., has tentative plans for the rebuilding of its plant and steam power department, recently destroyed by fire with loss estimated at $100,000, including equipment.

S. C., Pageland—Plans are under way for the rebuilding of the portion of the Pageland Ice Plant, operated by E. C. Brown and R. A. Carpenter, recently destroyed by fire. An official estimate of loss has not been announced.

S. D., Rapid City — The Rapid City Packing Co., has plans under way for the construction of a two-story ice and cold storage plant, 42 x 82 ft. James C. Ewing, Rapid City, is architect.

S. D., White River—The Village Council will commence the immediate construction of a dam on the White River, to be followed by the erection of a hydro-electric power plant for municipal service. The J. C. Jacobson Engineering Co., 1624 Harmon Place, Minneapolis, Minn., is engineer.

Tex., Austin — The Board of Public Works is having plans prepared for the construction of pumping plant for waterworks extensions and improvements, including electric-operated pumping units, with filtration plant, estimated to cost $300,000. John B. Hawley is consulting engineer.

Tex., Athens—The Hugh Drane Ice Co., will commence the construction of a new ice-manufacturing plant. Machinery will be electrically-operated. It is estimated to cost approximately $35,000.

Tex., Kerrville — The City Council has authorized plans for the installation of a sewerage disposal plant, with electric pumping equipment and auxiliary apparatus. A bond issue of $78,000 has been approved. The Municipal Engineering Co., Praetorian Building, Dallas, Tex., is engineer.

Tex., Port Arthur—The Port Arthur Ice & Refrigerating Co., is completing plans for the erection of a one-story ice-manufacturing and refrigerating plant, 125 x 150 ft., on site in the vicinity of its present plant on Lake Shore Drive, estimated to cost approximately $48,000, with machinery. A list of equipment to be installed will soon be arranged.

Tex., San Antonio — The San Antonio Public Service Co., will make improvements in its local steam-operated power station, including remodeling of switchboard and other departments, estimated to cost in excess of $100,000. E. H. Kifer is president and general manager.

Tex., Waco—The Board of Works is arranging plans for the installation of a sewerage disposal plant, with electric pumping and auxiliary power equipment, to cost close to $200,000. A bond issue of $350,000 is being provided for this and other municipal work.

Va., Chatham—The Common Council will install pumping machinery, steel tank and other equipment at the municipal waterworks in connection with extensions and improvements to cost $45,000, for which bonds have been voted.

Va., Newport News—The Supply Officer, United States Navy Yard, will take bids at once for 225 steam and water valves, N. S. A. F. req. 57.

Va., Norfolk—The Supply Officer, United States Navy Yard, will take bids at once for one oxygen compressor, N. S. A. F. req. 457.

Wash., Anacortes—The City Council has preliminary plans under consideration for the installation of a pumping plant at its proposed waterworks, using Lake Campbell as source of supply, estimated to cost $100,000. City Engineer Short is in charge.

Wash., Seattle—Barton & Co., plan for the installation of an ice and cold storage plant at their proposed packing plant on site acquired in the Meadows Race Track section, near the city limits, estimated to cost $800,000.

Wash., Seattle—The Pacific Nitrogen Co., affiliated with the Pacific Ammonia & Chemical Co., has tentative plans for the construction of a power house at its proposed new plant on Lake Union, estimated to cost $250,000.

Wash., Seattle — The Shell Oil Co. of California, San Francisco, is considering the construction of an oil storage and distributing plant on Harbor Island, with installation to include a number of large electric pumping units and auxiliary equipment, estimated to cost $500,000.

Wash., Walla Walla—The Cty Council is arranging a special election to vote bonds for $750,000, for the construction of a municipal electric power plant.

W. Va., Fairmont—City Director, J. C. Morris, will receive bids until Jan. 19, for the installation of a filtration plant at the waterworks, including pumping and auxiliary machinery, estimated to cost $125,000.

Wis., Madison—The Madison Gas & Electric Co., Fairchild Street, has preliminary plans for the installation of additional equipment at its local power plant, including a 5,000 kw. turbo-generator, two 1,000 hp. boilers, and auxiliary equipment. Mead & Seastone, Madison, are engineers.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances—Cotton waste higher in New York. No. 14, solid single braid rubber-covered copper wire higher in New York. Babbitt metal (35 per cent tin) ½c. higher in Cleveland.

Declines—Discounts lower in some of the armored cables. Cement 5c. per bbl. lower in New York.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled		51½c. per ft.
Common, 2½-in., 3-ply	$1.00 per ft. list less 40–10–5%	

	Air—Best grade	
¾-in., per ft.	3-ply $0.33	4 ply $0.42

Steam—Discounts from List
First grade....40–5% Second grade....45% Third grade.....50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:
Competition..... 60–5% Best grade..... 50–10–5%

LEATHER BELTING—List price, 2c. per sq. in., per ply.

Grade	Discount from list
Medium	40–2½%
Heavy	30–5%

RAWHIDE LACING { For cut, best grade, 45–5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duc. and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		45@50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@$2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.64 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	11.00@14.00	15.00	14.00
Colored	9.00@14.00	12.00	10.50

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	16.00	16.00
New York	9.00	.....
Cleveland	$36.00 per M.	$52.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.95	$1.00	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	14.00	12.75	15.50	14.25
White	14.00	12.75	14.00	12.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	50%	60%	60%
Tinned	50%	60%	4½c. per lb. net

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.
New York.....$4.40 Chicago.....$3.75 Pittsburgh....$2.65@2.85
Boiler rivets, same sizes:
New York.....$4.50 Chicago.....$3.85 Pittsburgh....$2.85@3.00

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	26@31
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	30@35
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	42.00@43.50
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	41@48
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	42@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	42@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	36@43
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	37@39
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	37@39
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	52.00	59.50	48@52
(35% tin)	25.00	18.50	22@25

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.40	$3.90	$4.30
Flats, square and hexagons, per 100 lb. base	4.90	4.40	4.80

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
⅛ to 3	62	50½	1 to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
4	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
1	.20	.25	.21
1¼	.23	.29	.23
1½	.24	.33	.28
2½	.....	.....	.....
2	.30	.41	.32
2¼	.32	.47	.35
3½	.34	.51	.37
2	.43	.64	.47

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 46.00 (net)	$ 70.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	35%	15%
Coils to 1,000 ft.	40-5%	20%
1,000 to 5,000 ft.	45-5%	25%
5,000 ft. and over	50%	30%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$61.10	$66.16	$9.90	$11.03	$5.74	$6.16
⅜	79.20	84.95	13.00	14.49	8.18	8.78
½	112.06	122.19	19.26	21.46	10.65	11.42
¾	151.62	165.31	25.65	28.33	14.76	15.78
1	181.28	197.67	34.19	37.77	18.23	19.47
1¼	248.90	265.94	62.70	69.24	24.29	25.97
1½	385.50	420.48	102.58	111.33	34.71	37.10
2	504.29	548.81	273.40	302.12	51.66	55.63
2½	633.86	688.65	604.03	667.15	69.41	74.19
3	772.62	838.59	697.06	770.99	86.76	92.73

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.10	D. P. D. B.	$0.32
D. P. M. L.	.16	T. P. S. B.	.30
T. P. M. L.	.24	T. P. D. B.	.42
D. P. S. B.	.18		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.75	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.90	.....
T. P. S. B.	.65	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.15	3.00	.....
T. P. to D. P. D. B.	.80	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	29.00
No. 18 cotton reinforced light	19.50
No. 16 cotton reinforced light	22.50
No. 18 cotton Canvasite cord	17.00
No. 16 cotton Canvasite cord	19.25

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.20	3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp.	100	30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.70
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.32	$0.37	120	75	$0.55	$0.60	60
15	.32	.37	120	100	.70	.75	24
25	.32	.37	120	150	.90	.95	24
40	.32	.37	120	200	1.15	1.25	24
50	.32	.37	120	300	1.75	1.85	24
60	.37	.42	120				
				500	2.50	2.65	12
				750	3.75	4.00	8
				1,000	4.25	4.50	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.19
Composition 2-piece attachment plug	.29
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 7.00	$ 9.27	$10.75	$17.20
12	9.50	11.79	13.40	23.40
10	12.70	15.50	17.20	29.00
8	17.50	19.80	22.87	38.00
6	.....	.....	32.00	.....
4	.....	.....	43.75	.....
2	.....	.....	64.00	.....
1	.....	.....	85.50	.....
0	.....	.....	109.00	.....
00	.....	.....	132.00	.....
000	.....	.....	159.00	.....
0000	.....	.....	189.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	⅜ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30-5%
$50 list value or over	35%